WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

AMATEUR RADIO

73

December 1969
75¢

1969 INDEX
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of Ham Gear
Freq Meter,
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73 Magazine #111, December 1969

Features

2 de W2NSD/1
4 Leaky Lines
25 Keep Wire Neat
46 A Ham's Christmas
61 Burr Removal Tool
110 FCC Announcement
111 Lowering Values
112 Buyer's Guide
122 Sticky Relay Contacts
122 SEXtupler Corrections
123 Low-Band Nomograph
129 Buy or Rent?
130 Letters
134 Errata
136 Caveat Emptor
139 DX Acrostic
139 Propagation Chart
140 Index to 1969 Articles
144 Index to Advertisers

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Contents

6 Quick, Easy, Dependable Transistor Diode Checker W6ICC
For those who like checkered diodes.
10 Did Samuel Morse *Really* Invent the Telegraph? W2FEZ
Telegraph? What's that?
14 Combination Dummy Load/Attenuator Network W2EEY
Also doubles as a hot plate for your coffee warming.
18 Tuned Filter Chokes – The Easy Way W2OLU
Can your filter chokes carry a tune?
22 Hey OM – You've Got Carrier There W4NVK
"Drop dead, you knit-picker."
26 Bandswitching the Swan-250 and TV-2 ....K3LNZ
For both six and two meter operation lickety-split.
28 Cheap and Easy Selectivity W5INU
A CW audio filter for under $10. Cheap enough.
30 VHF-FM – Part III: Hand Held Portables WB2AEB
Part 3 in our effort to brainwash you into trying FM.
32 Sunspots and the Ham WB2VFX
If you can't beat 'em, join 'em.
34 SSTV SM0BUO
Lecture at the International Congress of Amateur Television.
40 Amateur Radio in the Classroom K0HUD
Drives the kids right out of their everlasting minds.
48 The Galaxy RV-550 Remote VFO W6AJZ
Test Report from an excited and happy user.
50 Calculation Made a Little Easier W1EZT
Stuff our dumb high schools should have taught.
58 Universal Dual-Frequency Crystal Calibrator W2EEY
Using those new IC circuits.
62 Versatilize Your Transceiver VE3ECU/W0
Adding incremental tuning, a blessing in no disguise.
64 Transistor Class B and C Power Amplifier Design ... VK3ZRY
Slide rule lovers, arise and rejoice. . .an article for you!
70 Two for Mobile K6ZFV
Power supplies, not a love story.
72 Amateur Microwave Frequency Meter – 1 to 10 ghz ..K1CLL
Simple, but necessary test equipment for ghz tinkerers.
77 Audio Organizer WB2WYO
Nice companion unit for the station transceiver.
78 Converting a CB Transceiver to Six Meters WB6BIH
What else can you do with them?
82 Extra Class License Course, Part XI ....Staff
Oscillators.
102 Topographical Maps for the Radio Amateur W9VZR
For transmitter hunts, and other hammy applications.
106 Fascinating Fundamentals III: Magnetism W2FEZ
An irrelevant dip into history.

On the Cover

Commemorating man's first landing on the surface of the moon, this special 73 Christmas cover reminds one not only of the universal quest for peace on earth but also some of the good that has come from modern electronic technology. Early—and recent—amateur radio experimentation and pioneering has contributed vastly to the new pioneering in space exploration. Yet, not surprisingly, many standard switching components used extensively in current ham projects also played a vital role in the Apollo mission in both spacecraft and ground support equipment.

All standard distributor items, the following are shown on the cover from bottom to top (you'll recognize Astatic D-104 microphone at right, we're certain): Oak Manufacturing Co.'s 10-position, 0.300-in. diameter rotary switch (the world's smallest, by the way); at bottom, Oak's one-half inch diameter precision rotary switch; at bottom right, Hart-Advance's microminiature hermetically sealed relay (blue color); in front of pushbutton complex is Hart-Advance's easily recognizable continuous duty general purpose relay; centerstage, Oak's pushbutton switch, four-pole, double-throw per plunger; astronaut is "working" on Oak's ceramic section rotary switch; in far background, Hart-Advance's "VersaPac" miniature industrial relay. Both Hart-Advance and Oak Manufacturing Co. are divisions of Oak Electro/Netics Corp., Crystal Lake, Ill. 60014.

...de W2NSD/1

Wayne Green

SEASON'S GREETINGS from the 73 staff

73
Magazine

Here is the whole gang!

In the top row you will see Phil Price, an actor turned production man, who supervises the typesetting, drafting, layout and makeup of all the articles in each issue. Next to him is Lin Green, wife of the publisher, who helps with circulation, though her primary occupation is painting.

In the middle row we see Walter Manek, our resident sculptor, who keeps the 73 Headquarters in repair, helps with the mailing, and several hundred other jobs. Next to Walter is Diane Shaw, our advertising manager. Diane is knocking the advertisers for a loop. Diane writes poetry, rides horseback, and is an all around doll. Dotty Gibson handles our subscriptions and battles our ever efficient computer service down in Massachusettes. Roger Block, to her right, an artist, is our production manager and gets the magazine ready for the printer each month. The November cover was his work. By the "e" is Don Weiss, our circulation manager. Just below Don is Jane Tracey, who sets most of the type for each issue on the IBM Composer.

On the bottom row is Jeanne Caskie, who lays out most of the pages of the magazine and does finished paste-up of the pages and ads. Jeanne has a hobby of painting Cymbolics. . .we'll try and get her to do some on amateur radio. Wayne is next, eager to be operating from Y1, but too overloaded with editorial and publishing work to get away. Whitney Tobias, Wayne's right arm, is on his left (your right). On the right is Joe LaVigne, our bookkeeper, who runs an antique shop in his spare time.

What About Christmas?

Christmas is, for most of us, by far the most outstanding time landmark, measuring off the years even more definitively than birthdays. Coming as it does at the end of the year, it is a time of tidying up things for the year just past. . .a time for remembering, a time for thanking. It is fitting that Christmas is followed quickly by New Year's, a time for looking to the future.

Though it is admittedly a great effort, I shall attempt to refrain from joining the rush to commercialize on Christmas by suggesting, even casually, that you remember your amateur radio friends with a subscription to 73. Restraint such as this does not come naturally to me, you realize. It is even more difficult to exercise this restraint when I recall the pleasure that I felt all through the last year when gift subscriptions to magazines arrived each month. My moral fibre is firm, however, and my convictions resolute; I shall say nothing.

Instead, I would like to suggest that you take a few moments to remember back over this past year and add the names of your particular amateur radio friends to your family Christmas card list. Perhaps you have made some interesting contacts in some of

(continued on page 128)

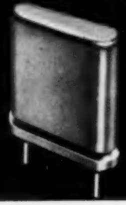
For The Experimenter!

International EX Crystal & EX Kits

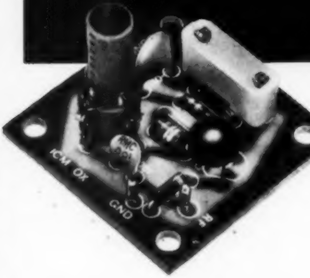
OSCILLATOR / RF MIXER / RF AMPLIFIER / POWER AMPLIFIER

Type EX Crystal

Available from 3,000 KHz to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is ±.02% when operated in International OX circuit or its equivalent. (Specify frequency)



$3.95



OX OSCILLATOR

Crystal controlled transistor type.
Lo Kit 3,000 to 19,999 KHz
Hi Kit 20,000 to 60,000 KHz
(Specify when ordering)

$2.95

MXX-1 Transistor RF Mixer **$3.50**
A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX oscillator are used for injection in the 60 to 170 MHz range.
Lo Kit 3 to 20 MHz
Hi Kit 20 to 170 MHz
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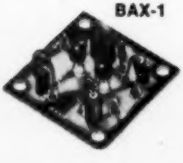
MXX-1

SAX-1

PAX-1



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SAX-1 Transistor RF Amplifier **$3.50**
A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output.
Lo Kit 3 to 20 MHz
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(Specify when ordering)

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A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw can be obtained depending on the frequency and voltage. Amplifier can be amplitude modulated for low power communication. Frequency range 3,000 to 30,000 KHz.

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General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 6 to 30 db gain. Ideal for SWL, Experimenter or Amateur.

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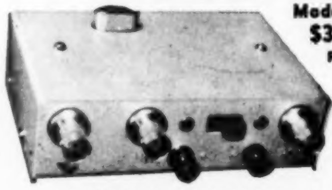

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or 146-148 MHz with a second crystal

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Leaky Lines

Unfortunately, I must depart from the subject of Amateur Radio at the very start of this, because of a disturbing turn of events. In all this time . . . six months or so, since I have figuratively thrown down my gage in an attempt to challenge the QST editorialist to a dialogue within the pages of both magazines, no one has accused me of anything underhanded or dishonest. No one has taken umbrage at my remarks in a violent way. No one, that is, until now.

I am in receipt of a letter, unsigned of course, which among other things, calls me a left wing radical, communist, socialist, anarchist, pinko, S.O.B., nigger-lover (sic), and God save the mark, a homosexual, although the term used refers to a specific act of sexual deviation, rather than the aberration itself.

As if this weren't enough, I have gotten three phone calls, also anonymous. The first was another choice selection of unflattering appellations, the second was a threat to break both my legs, and the third . . well, the third came at two o'clock this afternoon (Sunday, October 5) and awoke me from my complacency. I am worried about this one, I don't mind telling you. This phone call threatened my wife and little son!

I called the police and telephone company at once, and reported the incident, of course. I have also made sure that my S & W Magnum is always close at hand. I want to assure the screwball who called that if he should be rash and stupid enough to try out his threat, he is likely to learn a lesson that he may not survive long enough to profit from. I will not hesitate to put a slug right into his belly.

I wish to assure everyone that I do not believe in using ad hominem arguments. I do not believe in personal vendettas or below-the-belt kicks. I say this, not because I consider it necessary to issue a position statement to anyone but the over-zealous, super-loyal anonymous foul-mouths who are responsible for this agony into which I and my family have been plunged.

It is cowardly and scurrilous enough to write an anonymous letter, filled with foul, filthy names. But when you make a phone call, threatening the lives of my wife and child . . that is the most unspeakably debased level to which you can sink. I urge that you seek the help of a doctor, whoever you are. You are sick, and your sickness will not only destroy you; it will destroy those whose interests you believe you are furthering. You are doing them about as much good as Jack Ruby did for the Kennedy family . . . none.

* * *

Conceptually, there have always existed differences concerning priorities in the scale of values in Amateur Radio. Traffic people regard rag-chewers with an attitude of rage and intolerance. Rag-chewers loathe and despise contest enthusiasts.

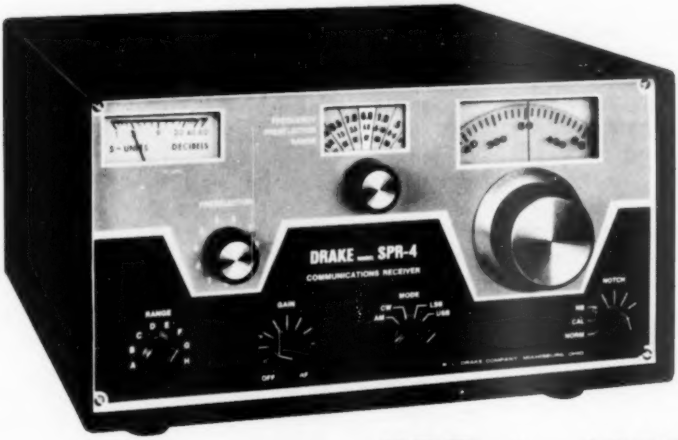
(continued on page 124)

DRAKE

- *Direct Frequency Dialing*
- *Programmable Coverage*

COMMUNICATIONS RECEIVER

- *All Solid State*
- *FET Circuitry*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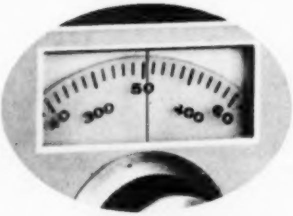
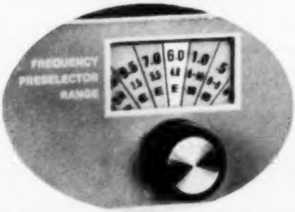


Precision tuning dial . . . tune station frequency directly . . . no searching.


FREQUENCY
PRESELECTOR
RANGE
7.0
6.0
1.0

Programmable frequency coverage . . . change crystal and label on dial.

The SPR-4 is a general purpose receiver which may be programmed to suit any interest: SWL, Amateur, Laboratory, Broadcast, Marine Radio, etc. Frequency Coverage: 150-500 KHz plus any (23) 500 KHz ranges between .500 and 30 MHz.

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For more information write

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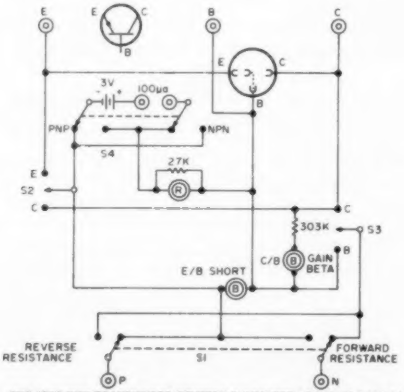
Q. E. D. Quick, Easy, Dependable Transistor Diode Checker

Charles Witkowski W6ICC
7859 Compass Lake Drive
San Diego, CA 92119

The ohm-meter method of checking transistors is not new, and no claim for originality in this category is made with the instrument to be described. What is to be presented is an inexpensive switching device used in conjunction with an ordinary volt ohm-milliameter to quickly measure the more common transistor parameters. We leave the more sophisticated and expensive types of transistor testers (some costing close to $100) to the design engineers and manufacturers.

The schematic shown in **Fig. 1** is straightforward and self explanatory, the entire unit being built into an LMB box chassis 5¼" x 3" x 2 1/8".

Referring to photo **Fig. 2**, starting at the bottom the two insulated tip jacks marked P and N are for connection to the ohm-meter.



PNP (FOR NPN TRANSISTORS REVERSE OHMMETER LEADS AT P AND N)

Fig. 1. Complete circuit diagram.

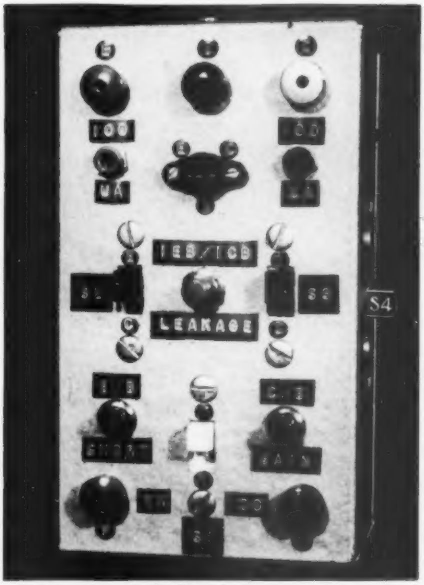


Fig. 2.

Next in the lower center is a DPDT slide switch S1 marked F and R for forward and reverse readings. Next, on the left is a black push button E/B shorting switch. On the right is the C/B gain black push button switch. In the center on the left is a SPDT slide switch marked S2 to connect the P line to either the emitter or collector and marked E and C.

In the center is the IEB/ICB leakage test red push button. This button undepressed allows a protective 27K resistor to be in series with the 3v battery and a 100 microammeter. In the event of an EB or CB short, the meter would show full scale reading or zero ohms. If so, do *not* depress this button, as you would end up with a blown microammeter. If the reading is in the neighborhood of 50K or plus ohms, then it is safe to depress the leakage button, shorting out the 27K resistor and reading the true leakage current in microamperes.

To the right of leakage push button in center is an SPDT slide switch marked S3 to connect the N line to either the base or the collector and marked B and C. Above the leakage button is the transistor socket, and to either side are the two tip jacks for the 100 microammeter.

On the top row are three insulated tip jacks marked E, B, and C and connected to E, B, and C of the socket. Make three 6" leads with a phone tip on one end and a small alligator clip on the other and color code them to match the color code of the three E, B, and C tip jacks. These will be useful in testing power diodes and power transistors. S4 (mounted on the side of the box) is a DPDT polarity reversing slide switch used in conjunction with the internal 3 volt battery and the 100 microammeter for testing PNP and NPN types respectively, and so marked.

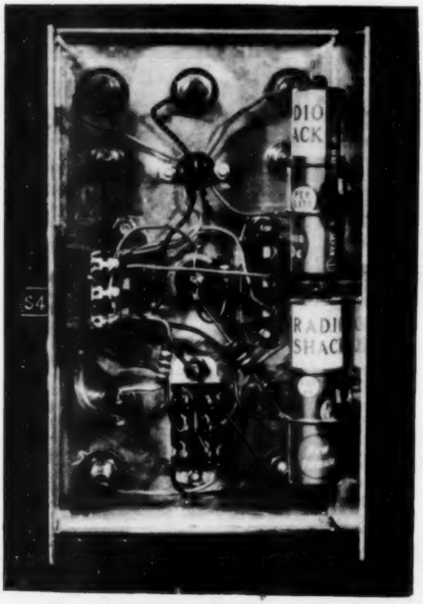


Fig. 3.

Placement of parts is not critical but the symmetrical layout shown in Fig. 2 is desirable for convenient orientation of tests as will be shown later in detailed step by step procedure, not only. for checking but also to identify all leads of unmarked transistors and diodes.

The first thing to determine is the true polarity of the ohmmeter leads. Most ohmmeters, with the exception of the Simpson model 260, have their polarities reversed on ohms. That is, the black or common lead is tied to the positive of the battery and the red lead is tied to the negative side of the battery. A quick check of your ohmmeter can be made as follows. Take any marked diode and measure its resistance. In one position the resistance will be low, and in the reverse position the resistance will be high.

The negative lead of the ohmmeter will be the one that is on the cathode of the diode when it is in the low resistance position. The cathode end of a diode is usually marked with a black band. In any case, it is the lead opposite the arrow in the diode symbol.

The following tabulated tests will be for PNP type transistors only. For NPN transistors, reverse the positive and negative leads at the ohmmeter. The same thing can be accomplished by reversing the position of slide switch S1 with a corresponding mental change of the markings F and R for the NPN types. It was found to be less confusing to just change the leads at the ohmmeter and forget the cerebral gymnastics when testing the NPN's.

Most transistor tests will be with the ohmmeter in the R x 100 position. This in most cases will apply a maximum of 1½ volts to any configuration of the transistor and should not harm it. To get a more accurate reading of the reverse resistance of both junctions, it may be necessary to go to the R x 10K position, but here again take into consideration the voltage rating of the transistor as most ohmmeters employ voltages anywhere from 4½ to 15 volts in the higher resistance positions. A word of warning to the wise!

Now for the tests–

Forward Resistance of Both Junctions. EB-CB

A. Ohmmeter (Rx100 scale) Leads in P and N
B. S1 to F
C. S3 to B
D. S2 to E and to C
   High resistance reading=open junction
   Below 500Ω reading=normal transistor

Reverse Resistance of Both Junctions. EB-CB

A. Change Ohmmeter to R x 10K position (See warning paragraph in text.)
B. S1 to R
C. S3 to B
D. S2 to E and to C
   1. Low resistance reading denotes a *shorted* or *leaky junction*.
   2. Low or medium power germanium transistors should show a resistance reading of at least 500KΩ
      (Average about 700K to 1.5 meg.)
   3. Silicon transistors should show *high* resistance readings
   4. Power transistors should show readings of 50K or greater

Current Gain (I ceo)

A. R x 100 Ohmmeter Scale
B. S1 to F
C. S2 to E
D. S3 to G
E. Depress rt. black C/B gain button
   1. Meter should show increase in current. (Decrease in resistance reading)

Dynamic Test (Go-No go)

A. S1 to R
   S2 to E   High resistance reading
   S3 to C
B. Press E/B short button
   Transistor is O.K. if low resistance reading indicated (less than 500Ω)
C. If only slight resistance change noted on pressing E/B short button, the transistor is defective.

Leakage current–Icbo and Iebo

A. Remove Ohmmeter from P and N
B. S4 to PNP or NPN
C. + 100 μa meter lead to red 100 μa pin jack.
D. - 100 μa meter lead to black 100 μa pin jack.
E. S2 to E → press red leakage button
F. S2 to C → press red leakage button
   1. Low and medium power transistors (10 to 15 μa at room temp 20^{o}c-68^{o}F)
   2. Power transistors–100 μa or more.
   3. Silicon junctions–Fractions of a microampere
   4. Estimate leakage currents at other temperatures by doubling leakage current for each 10^{o} centigrade rise in temperature.

Beta Measurements

A. Remove Ohmmeter leads from P and N
B. S2 to C
C. S3 to C
D. + of 3v battery to emitter
E. - of 2 ma meter to - of 3v battery
F. + of 2 ma meter to collector
G. Press rt. black C/B gain beta button

$$\underset{(D\text{-}C)}{\text{Beta}} = \frac{I_c}{I_b} = \frac{1000\mu a}{10\mu a} = 100$$

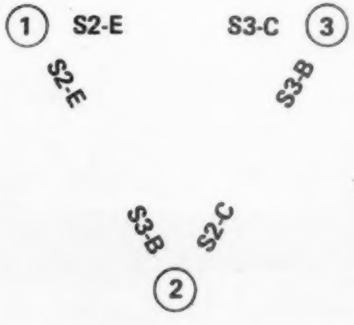
(If meter reads 1 ma or 1000μa)

Beta A-C

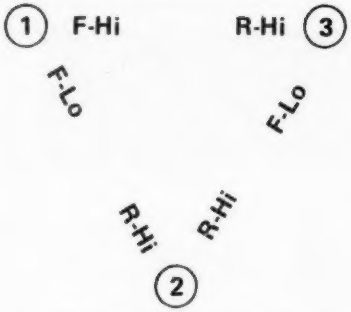
1. Take collector current reading with base open
2. Press C/B gain beta button and note change in Ic current.
3. Change in Ic/10μa = AC Beta

Unmarked Transistor Leads (Base Identification

A. Consider E as (1) unidentified lead
   Consider B as (2) unidentified lead
   and C as (3) unidentified lead
B. Switch set up



C. S1 to F and R



Base is lead *not* involved in the two high resistance readings in the 1-3 position above.

Unmarked Transistor Identification

A. Type PNP or NPN
  1. Low resistance reading when base is negative and positive is connected to either collector or emitter then transistor is a PNP type.
  2. Low resistance reading when base is positive and negative is connected to either collector or emitter then transistor is a NPN type.

B. Collector and Emitter Lead Identification
  1. Take forward and reverse readings between collector and emitter.
  2. The lower resistance reading signifies that the negative terminal of the Ohmmeter is connected to the collector lead of the transistor.

Diodes

A. Ohmmeter (R x 100 scale) to P and N
B. S1 to F
C. S2 to E
D. S3 to C
E. Connect anode to pin jack E
F. Connect cathode to pin jack C
G. Forward reading 500Ω or less (10Ω or less on R x 1 scale)
H. S1 to R
I. Reverse reading–50KΩ or higher

Unmarked Diode–Cathode Identification

A. Ohmmeter (R x 100 scale) to P and N
B. S1 to F
C. S2 to E   E will be +, C will be -
D. S3 to C
E. Connect diode to pin jacks E and C
F. Take resistance reading
G. Reverse diode at pin jacks E and C
H. Take resistance reading
I. With the low resistance the negative lead of the Ohmmeter (Pin jack C) will be connected to the cathode.

Alternate Method–Quick Check of Power Transistors for Leakage and Gain

A. Ohmmeter (R x 1 scale) leads in P and N
B. S1 to F
C. S2 to E
D. S3 to C
E. Connect power transistor to corresponding pin jacks E-B-C
F. Leakage
  1. The lower the Ohmmeter reading the higher the leakage.
  2. Zero indication = transistor shorted.
G. Gain
  1. Shunt B-C pin jack terminals with a 1.5K-½ w resistor
  2. Reading of over 60 ohms = low gain
  3. Reading of between 25 and 39 ohms = medium gain
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As an exercise to check out the tester, a "surprise" pack of 25 unmarked transistors was purchased from a local radio store for $1.00. Some twenty minutes later, it showed 10 PNP and 6 NPN transistors that were perfectly okay. Nine transistors were defective.

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Did Samuel Morse Really Invent The Telegraph?

Long before the birth of Samuel F.B. Morse in 1791, the English were communicating via a system which they called "telegraph." This system, however, had nothing whatever to do with electrical communication. It consisted of a series of high towers with large wooden vanes at the top. The vanes were moved by a cable and pulley arrangement, sending a semaphore message. A system was set up in this country in 1800 to advise Boston merchants of incoming ships. It flashed word all the way from Martha's Vineyard.

Even before the semaphore telegraph systems, electrical communication had been possible. It was just that nobody had thought of it. In 1730, for instance, a man named Stephen Gray had carried out the first experiments in conduction, and had sent currents over hundreds of feet of hempen rope. In 1747, Wilbur Watson sent Leyden jar impulses from the rooms of the Royal Society over miles of wire strung on the London rooftops. Both of these men could have used their set-ups to send some sort of elementary message – – *if* they had thought of it.

It was not until 1753 that anything even vaguely resembling the idea of a telegraph was so much as suggested. The credit goes to an unknown magazine reader who suggested to the editor that messages could be sent from one location to another by means of as many *pairs* of wire as there are letters in the alphabet! A system using 24 wires was installed at Geneva in 1774. It was quite expensive, each wire being buried in a separate glass tube, and the signals were Leyden jar discharges, not sustained currents.

A system was set up and operated in 1812, which used 35 separate circuits, and detected the signals by producing hydrogen and oxygen bubbles in jars of water, one for each circuit (and *we* think 5 wpm is slow!). Operating systems were set up in England and on the continent in the 1830's, but while they did work, they were still very complicated. Giving credit where it is due, the Russians had Baron Schilling who made a workable system in 1825, but the Czar thought the idea of people communicating from one end of the land to another was subversive! He forbade any mention of it by the press.

At long last Morse was to enter the picture. He was born in 1791 in what is now one of the poorer sections of Boston, Massachusetts. Frankly, he didn't know a blamed thing about electricity, as some of his earlier sketches reveal. Originally he was an artist, and a good one at that. In 1817, for example he was able to pull down as much as $240 a week. Even at today's prices, that ain't hay. For a time he was the nation's number one artist. He visited the Louvre in 1831-32 and made copies of many great masterpieces which many of his countrymen otherwise might never have seen. The return trip was the great milestone of his life.

He boarded the packet "Sully" to come home, a talented and inspired painter. While enroute, he got into a conversation about the works of such men as Michael Faraday and Joseph Henry. Then the bug bit him. The voyage lasted a month, during which time he occupied himself making rough drawings of a daring idea. While the sketches clearly showed his ignorance of electricity, the principle was well illustrated. "When you hear of the magnetic telegraph," he said to the captain, "remember that it was invented on the Sully."

As soon as he got home, Morse started work. His ignorance of electricity was playing against him, however, the darned thing just would not work. For three long years he swallowed one disappointment after another. In the meantime his wife died and he was left with three children to care for. He had to turn back to painting. In 1835 he was made a professor at the new University of the City of New York. It didn't pay

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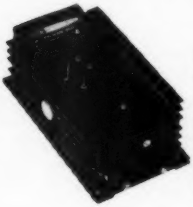

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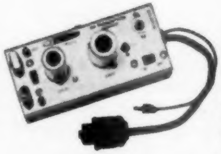

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much, but it helped keep him and his children from starving. At last he could get back to his inventing.

Try as he might, however, it just would not work. He wound magnet after magnet, but somehow they didn't magnetize. It was pathetic. Morse had a friend named Leonard Gale who had read some of Joseph Henry's work. Gale looked over Morse's apparatus and then told him what was wrong. We shouldn't be too hard on Sam. After all, he was an artist, not an electrician. Nobody had told him the wire used for a magnet had to be *insulated*! Morse tried again, and this time the results were encouraging.

Morse's set-up was much simpler than any others which had been tried in Europe, but still it was unnecessarily complicated. There was no key such as we use. The circuit was made and broken by a series of metal slugs notched in the proper places and inserted into a machine which moved them past a metal finger. As the finger passed over the high areas of the slugs, the circuit was made and broken sending a pulsed code down the wire. The code which Morse first used was too complex to be read by ear. It was automatically traced on a moving paper tape by a stylus operated by an electromagnet.

Batteries in those days were nothing to brag about, and Morse's using a single battery didn't help his system any. Still, with Gale's help he did manage to get over 20 feet, then a hundred, and finally a thousand feet. Beyond that, the resistance of the wire was too much. In 1837 he was demonstrating his apparatus at New York University when he attracted the attention of a wealthy businessman, Stephen Vail. Vail offered to subsidize Morse with $2000 and lab space, provided Morse would let his son Alfred become his assistant. Morse agreed, making one of the luckier decisions of his lifetime. Alfred Vail proved to be a hard worker and a good thinker. Over the next few years he ironed some of the bugs out of Morse's code, got rid of the composing stick with its metal slugs, and greatly simplified the system to a practical and compact set-up. He invented a telegraph printer which he patented in Morse's name.

Long before, in the early 1800's a thirty thousand dollar prize had been offered by the government for any one who could come up with a practical telegraph system for the east coast. Morse got wind of that and appealed to congress. One congressman, Francis O. J. Smith was so taken by Morse's ideas that he resigned from congress to become Morse's "partner." Smith was to later prove to be a crook. An economic panic in 1837 put an end, at least for a while, to Morse's hopes for a federal grant. Morse, on Smith's advice, went to Europe to secure patent rights. He failed, since a couple of other telegraph systems had been long since working. They were, however, far more complicated than Morse's.

After his return, Morse called on Joseph Henry, inventor of the electromagnet, for help. Now Henry was quite capable of making a telegraph system. He just wasn't interested in doing it himself. Years before he had proposed a telegraph system that would have worked by ringing bells. (What a racket!) He took a liking to Morse and consented to help him. Very carefully and diplomatically he pointed out some of Morse's more glaring mistakes and showed Morse his newest invention, the relay. Morse had the brains to take Henry's advice.

Morse's crooked partner, Smith, managed to get a request for federal funds into congress by 1843. It was the last day of that session, and the congressmen were having a ball making corny jokes about the idea of using magnetism, which in that day was looked upon about the same way we look upon E.S.P. Bitterly disappointed, Morse went home. Next day, the daughter of the Commissioner of Patents brought Morse some badly needed good news. His grant had by some miracle been approved. Delighted, Morse promised her the privilege of being the line's first customer. It was she who composed the now immortal message, "What hath God wrought?"

The grant, for a sum of $30,000, called for a test line to be strung from Washington to Baltimore, a distance of 40 miles. Smith awarded the contract to himself, and charged $20,000 for the first few miles. The line itself was a coax type of an affair. After Smith got his money, Morse found out that Smith had not spent good money on such stupid things as insulation.

The contractor, Ezra Cornell, suggested stringing the wires overhead. Morse turned to his old friend, Henry, who seconded the suggestion. The wire was strung, using broken bottles as insulators, from posts and trees. It was completed just as the Whig convention was starting in Baltimore. Morse and his assistant, Vail, tested out the line by sending the news of Henry Clay's nomination. Politicians arriving by express were as-

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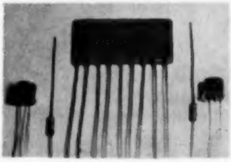

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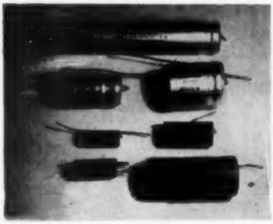

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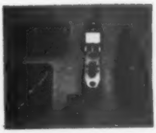

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tounded to discover that the news had gotten there ahead of them. Morse was asked to move his gear into the Supreme Court room of the Capitol. A large crowd gathered there to witness a delightful qso between Washington and Baltimore. Morse had it made.

From there, the telegraph took a one-way trip – up. Newspapers were quick to catch on, and the Associated Press was organized with its own wires. Thanks to a clever public-relations man, telegraph wires were strung as fast as poles could be set up and wire run. The rest is still happening.

The original question was, "Did Morse really invent the telegraph?" The answer depends on how you define the word invent. Now, Morse certainly did not conceive and build every little detail himself. Although he was to later deny the help of Henry and his friends in order to protect his patent rights against outside parties, their contributions are today well known, and all of them shared in the material rewards. Morse was the driving power behind an idea which, while others may have also conceived it, was still the product of his own imagination, and in spite of tremendous obstacles, Morse had the guts to push it through.

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John J. Schultz W2EEY
1829 Cornelia Street
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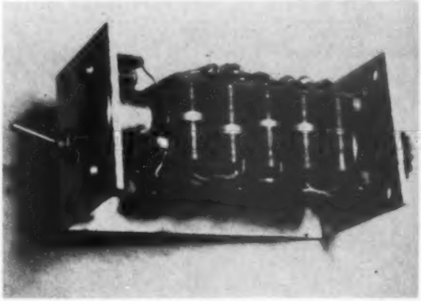
Combination Dummy Load/Attenuator Network

A simple, inexpensive unit is described for use between a transmitter–used as an exciter–and a linear amplifier which will both allow proper tune-up of the exciter alone and reduce the power drive level, as desired, to the linear amplifier.

There are many instances when it is desired to use an existing transmitter as an exciter unit for a high-power linear amplifier. Many such linear amplifiers require a drive level that is only a fraction of the transmitter's output. To some degree, the transmitter can be detuned in order to reduce its output level, but this procedure is rarely possible when several orders of magnitude reduction in the power level are necessary. In such a case one can either internally modify the transmitter for a lower output level or use an alternator network between the transmitter and linear amplifier. In the latter case, the transmitter can be operated at its normal power input level and with its tuning controls at their normal settings.

The unit described in this article functions as both an *rf* attenuator and as a dummy load. The latter capability allows a transmitter to be properly tuned alone for correct operation before it is used to drive a linear amplifier. An optional wattmeter circuit is included which when calibrated allows direct reading, in watts, of the full transmitter output or of the drive level supplied to the linear amplifier.



A simple method of construction is employed. Based mainly on "sandwiching" the resistors used between two pieces of vectorboard. Details are given in the text. SO-239 is used as coax input connector. The circuit function switch is located below the output connector.

Power Reduction	Resistor Factors a	Resistor Factors b
1/4 (6db)	.3	1.3
1/5 (7db)	.4	1.1
1/10 (10db)	.5	.7
1/20 (13db)	.6	.5

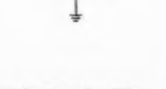


Fig. 1. Approximate resistor factors for "T" network attenuators over the ranges normally desired for exciter power output reduction.

The unit described was built for use with a nominal 100 output transmitter used primarily for SSB service. The construction used, however, can be extended to other power levels for transmitters operating on 80-10 meters. Also, using the information

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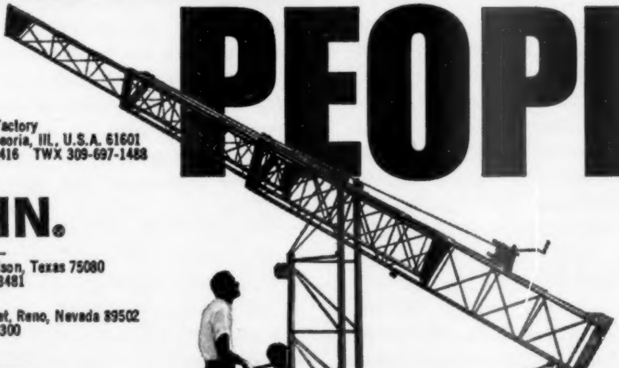

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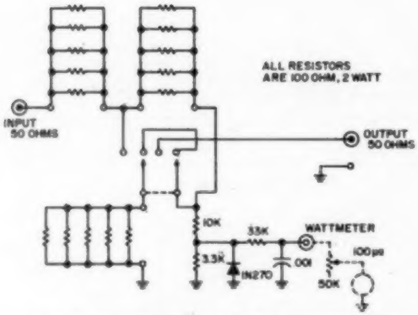

Fig. 2. Circuit of one possible dummy load/attenuator network providing about 10db power reduction. Optional wattmeter circuit is also included.

supplied, the same type of attenuator/dummy load can be designed for other than 50 ohm transmission line systems. The attenuator was not designed as a precision network in order to allow the use of inexpensive resistors. However, the attenuation characteristics are quite satisfactory for the intended usage.

Besides its application as a power reducer when driving a linear amplifier, the unit can be used with a transmitter whenever a quick, known level of power output reduction is needed for operating purposes, approximate gain measurements, etc.

Circuit

Fig. 1 shows the circuit values for a generalized T network attenuator that can be used in any impedance unbalanced transmission line. The scaling factors are only shown for those power reduction levels most likely to be needed when driving a linear amplifier with a 75-200 watt transmitter, in order to avoid unnecessary detail. Factors for intermediate power reduction values can be found by interpolation to a satisfactory degree or one can consult an electronics handbook. The basis of the attenuator/dummy load network is to find the combination of resistor arms that will provide the desired attenuation and still be able to be connected together to form a dummy load of the correct value. **Fig. 2** shows one possible combination. Each resistor bank has a value of about 20 ohms (5 resistors of 100 ohms each in parallel). In one position of the DPDT switch, the resistor banks are formed into a "T" network attenuator. In the other switch position, all three banks are placed in series as a dummy load connected across the input only. The resistance values which result are not exactly those shown in **Fig. 1** for a 10db alternator. However, they are close enough to be effective and some tailoring of the individual legs is possible since each of the resistor bank values vary by a few ohms due to the tolerance of the resistors used. An optional voltmeter circuit is also shown in **Fig. 2** connected to one pole of the DPDT switch. It can be used as a relative power output indicator or if calibrated, as described later, actually measure the power output of the transmitter and of the attenuator.

Many variations of the basic idea are possible. **Fig. 3** shows the use of four banks of 100 ohm resistors. All four are used to form an attenuator that comes reasonably close to the values required for 7db attenuation in a 50 ohm system. Only three are used in series for the dummy load function. In this case only a simple SPST switch is necessary to disconnect the output. The same *rf* voltmeter circuit as used in **Fig. 2** may be added if desired. The switch, in fact, could be eliminated entirely if one were willing to disconnect the output termination in order to use the dummy load feature.

Whatever combination of resistance banks are used in order to achieve a desired attenuation value and the correct dummy load resistance, care must be taken that each resistance bank has sufficient power dissipation capability. The dissipation in each leg of the "T" network varies according to the attenuation level and can be calculated by Ohms Law. In general, a continuous power rating for a resistor bank equal to about

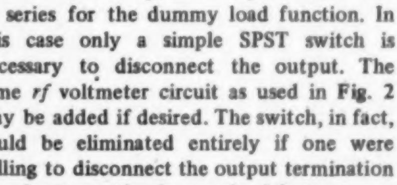

Fig. 3. Another dummy load/attenuator configuration possible with the 100 ohm resistor banks. It provides about a 1/5 power reduction (7db) when used as an attenuator.

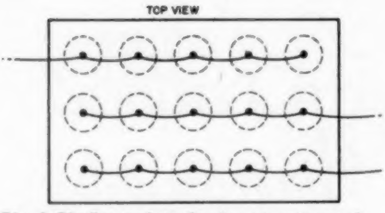

Fig. 4. Similar resistor banks are connected together on the underside of the assembly.

one-third of the SSB peak power rating seems to suffice, including for quick tune-up on CW. For keyed CW service, the power rating should be increased to at least one-half the key-down power level.

Construction

The approach of using a relatively large number of 2 watt composition resistors is far less expensive than using specific value *rf* non-inductive resistors of 10-30 watts power rating. In quantities of more than 10, IRC type RC-2, 2 watt, 10% tolerance resistors cost about 9 cents each. So, one can achieve a 40 watt unit for less than $2 resistor cost. Banks composed of these resistors work well up to 30 mc as long as the interconnecting leads are kept short.

The photograph shows the construction used by the author for the circuit of **Fig. 2.** Similar construction can be used for larger size units as well. As shown in the photograph, the 15 resistors in rows of 5 each are sandwiched between two 1-1/8" x 1-7/8" pieces of vectorboard. None of the resistors physically touches. The wiring is done using the resistor leads. This construction is somewhat compact to expect full, continuous power dissipation from the unit but suffices for intermittent use. The frame measures 2¾" x 1½" x 1½". A cover is not absolutely necessary since the minor radiation that takes place is not important in this application. If a cover is used, it certainly should be of a perforated type to allow maximum air flow. A SD-239 connector is used at one end of the frame for the input. A dual connector is used at the other end, but normally one would use two RCA type phono jacks–one for the output and one for a meter circuit. The switch is located immediately below the output connector–a miniature Alco MST type.

Calibration

If it is desired to calibrate the voltmeter circuit as a wattmeter, it is necessary to use a probe and VTVM. Using the unit as a dummy load, the *rf* voltage is measured at the input and the power calculated. The 50K ohm potentiometer is used to set the meter at full scale for the highest power level used. The *rf* voltage is measured and the power level calculated in order to calibrate the meter for lesser power levels leaving the potentiometer at its "set" value. The same procedure is followed to calibrate the meter for the output power level by measuring the output *rf* voltage when the unit is used as a "T" attenuator and connected to a regular dummy load. The calibration should be made on the lowest frequency band used and rechecked on the highest frequency band used. If the readings differ significantly on the highest frequency band from those established, it may be necessary to add a few mmf capacitance across the diode in the voltmeter circuit in order to compensate for the slightest reactance present in the circuit.

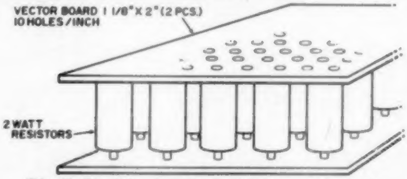

Fig. 5. Sketch showing details of resistor "sandwich" assembly.

Operation

When used between a transmitter and the 50 ohm input of a linear amplifier, the unit is first used as a dummy load for tune-up of the transmitter. The unit is then switched (with the transmitter unkeyed) to its attenuator position. In most cases, no returning of the transmitter should be necessary unless the input of the linear amplifier is particularly reactive.

Summary

The unit described is not intended as a precision attenuator or power measuring device. However, it will perform very well for its intended applications and costs far less than more sophisticated units performing the same functions.

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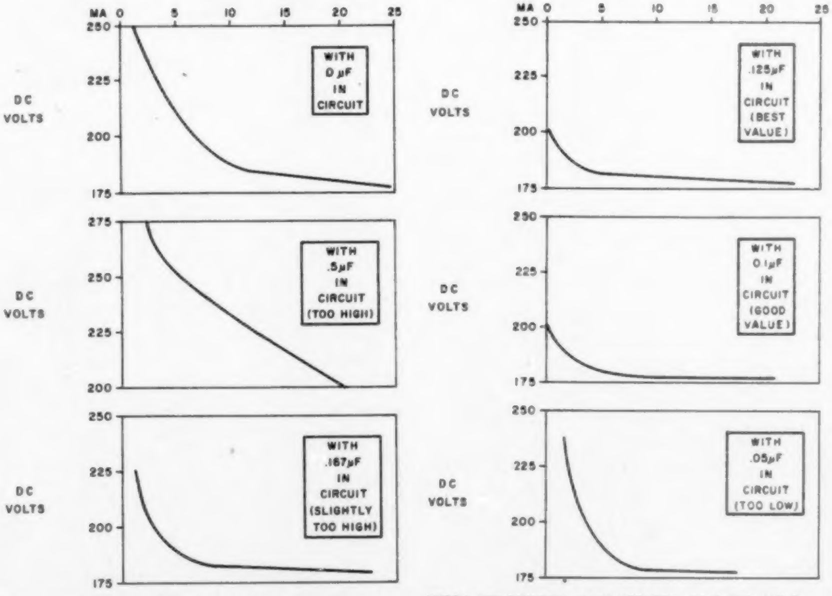
Tappan, NY 10983

Tuned Filter Chokes – The Easy Way

Amateurs and experimenters who "roll their own" often find themselves in a bind when it comes to designing power supplies which use a choke input filter. At low current, the power supply voltage will soar, unless a substantial amount of power is "bled" off through the customary bleeder resistor. An article in 73[1] went into detail with respect to a way out of this dilemma. For the benefit of those who missed this fine article by K6ZGQ, we might recapitulate his thesis that by tuning the input filter choke, a much higher impedance to 120 cycle ripple is obtained. Not only does this give a lower ac ripple to the dc output voltage, but it greatly improves the regulation of the power supply. Somewhat in the same vein, a shorter article by W6HPH described the means he utilized (an oscilloscope) to obtain basically the same objectives.[2]

I have discussed these methods with other amateurs, but the idea hasn't caught on to



NOTE: THE CURVES ABOVE DO NOT REFER TO ANY CHOKE OTHER THAN THE 8H CHOKE CITED......THEY ARE ILLUSTRATIVE ONLY.

NOTE: ANY CAPACITY VALUE BETWEEN .05µF AND .167µF RESULTED IN AN IMPROVEMENT OVER CHOKE INPUT TO THE FILTER.

Fig.1. Graphs illustrating numerous different capacitor values over a range greater than 3:1. Better power regulation is evident.

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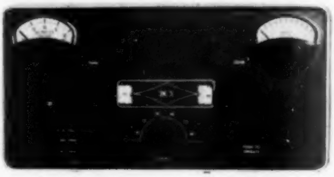

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any great extent. It seems that many hams are not too eager to experiment when a high-voltage power supply is the subject. Some hams do not possess the necessary equipment to run the required curves on the power supply output, showing voltage vs current. And a few may not understand the technique involved. It's a simple thing, and to make matters even easier, I have developed a method which works out very well in the majority of cases. This solution does not involve any complex testing equipment or needless exposure to high voltages.

Most amateurs are familiar with the ordinary 2.5 millihenry *rf* choke. If we shunt this choke with a 50 pf condenser, the resultant circuit will resonate in the neighborhood of 450 khz. In similar fashion, it is possible to shunt a filter choke with a suitable condenser and obtain resonance at a much lower frequency, in our case, 120 cycles. The values would be slightly different for hams where the supply lines furnish 50 cycle ac, and full-wave rectification would result in a ripple frequency of 100 hz.[5]

What values to use for resonance at 120 hz? The ARRL handbook[3] states that the magic number is 1.77, that is the product of L and C should be 1.77 or close to that figure. Example: if you had an 18 henry choke, shunted by a condenser of 0.1 mfd, the resultant product would be 18 x 0.1 or 1.8, very close to the 1.77 figure. It might be well to stress the fact that exact resonance is not required, a broad type of resonance seems to work out very well.

How to determine the inductance of the filter choke? Easy. Measure it on an inductance bridge, if you can do so. We are interested in the inductance at low current, or close to zero current. If the foregoing is not convenient, I have determined a simple formula that works out very well: read the manufacturer's rating for the choke, let's say it is rated at 10 henrys. Multiply this figure by 1.5 or by 2.0, depending upon the quality of the choke. This will be the approximate figure for the real inductance of the choke at low milliamperes. Thus our 10 henry choke, of good quality, would presumably show an inductance of 15 to 20 henries at low current. Assuming an average of 17.5 henries, we can shunt this with a capacitor rated at 0.1 mfd and this will result in a value (L x C) of 1.75, very close to the desired figure of 1.77 – this is not the least bit critical.

In my case, we had a high-quality choke, rated 8 henries at 475 ma. We estimated the low-current inductance to be approximately 1.75 times the rated inductance. This would indicate an inductance of 14 henries at low current. Theory indicates that a shunt capacitance of 0.125 mfd. would give a product of 1.75, close enough to the 1.77 figure. A series of test runs was made at various values of capacity, and the results are presented. Not only do these graphs illustrate the fact that we have obtained improved power-supply regulation, but the curves also show that the capacitor values may vary over a range greater than 3:1 and still effect an improvement over the "straight choke" input. Any good home-brew experimenter can come much closer than that, so the various curves are presented not so much as verification of the results obtained, but mainly to show how very simple the process can be. In our own case, the curves show that the filter capacitor used in shunt with the input choke could be of any value from 0.1 mfd. up to 0.167 mfd. with very little change in performance.

The 400 volt c. t. transformer was used for reasons of safety. The results were then checked on our large power supply, using a 2,000 volt transformer. Whereas our former bleeder current had to be 70 milliamperes at 1000 volts dc (an impossible figure), it is now greatly reduced to a more reasonable figure of 20 milliamperes, an improvement of 3½ to 1. The results are most gratifying: less heat loss, lower strain on the power supply, and more power for the rig.

By this time there must be a few

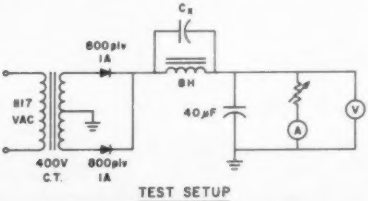

Fig. 2. Power supply test setup utilizing a high-quality choke rated at 8 henries @ 475 ma.

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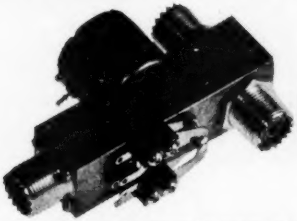
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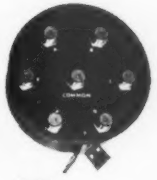

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SERIES 78 The series 78 coaxial switches are manually operated with true coaxial switching members (not wafer switches). They are offered in 2, 3, 4 & 6 position (illustrated) types, plus a transfer or crossover and DPDT. The useful frequency range is 0-1 Ghz except 500 Mhz using UHF connectors. The unused positions are open circuited or non-shorting. Also available with other type connectors such as N, BNC, TNC or C.

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doubters: the method outlined is so simple, how can it possibly work? Perhaps a reference to a well-known amateur publication, the Radio Handbook,[4] may be of help. In the 17th edition, there is shown the schematic and description of a 1 kilowatt power supply, designed for continous commercial service. The input filter choke is rated 6 henries at 700 ma. Ordinarily, this would call for a monstrous bleeder, capable of carrying umpteen mils at 2500 volts. Instead, the designers chose to "tune" the input filter choke, and to reduce the bleeder current by so doing. There is no doubt that these results were obtained in the laboratory after a thorough examination of the problem, and reflect careful engineering. The choke, 6 henries, would have roughly 12 henries true inductance at low ma and the filter capacitor chosen to "tune" the choke was rated at 0.15 mfd. These laboratory results come very close to the mystical figure of 1.77 (12 x 0.15 = 1.80).

Don't forget to use a high quality oil-filled capacitor for this application. The stress on the condenser is high, so make it a point to choose a condenser with a dc rating of at least double the output voltage. It shouldn't be necessary to say the electrolytic condensers are "taboo" for this function, although they may be used in other parts of the same supply. Some builders may find it more convenient to place the choke-and-condenser combination in the negative lead of the power supply. This will simplify the problem of voltage insulation, and the increased filter efficiency will be the same as when the filter choke is wired into the positive leg of the power supply.

. . . W2OLU

References:

1. *Some Thoughts on Designing High-Voltage Power Supplies*, Bob Nelson, 73, November, 1966, p. 30.
2. *Tuned Choke Inputs*, Fred Brown, CQ, October, 1967, p. 80.
3. *ARRL Handbook*, Fortieth Edition, p. 227.
4. *Radio Handbook*, 17th Edition, p. 743.
5. *RSGB Handbook*, Third Edition, p. 438.

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571 Orange Avenue West
Melbourne, Florida

Hey OM – You've Got Carrier There!

In listening to some hams on the air, it appears there is still some confusion about how to tell if you have excessive carrier leakage on an SSB rig. Quite frequently I hear some ham being ribbed about his carrier leakage by listeners close to his QTH, while his signal sounds fine to me.

Before going further, though, let me say there are some unreasonably critical hams on the bands, judging from a purely technical standpoint. This appears to be due, first, to a healthy ignorance of facts and, second, a determination to keep from learning facts different from long-held prejudices.

The particular ham I refer to here, however, is the one that will complain that "you've got carrier there" when the signal is really quite acceptable. This, of course, is a great disservice since such a report can cause needless troubleshooting on a perfectly okay rig. It could also be mentioned that if the listener were adept at tuning his receiver, he would never know the station had carrier, since carrier presence is inaudible in any decent SB rig until the receiver is mistuned by more than twenty to fifty cycles. Evidence that many hams have not mastered SSB tuning is abundant on any net. It is not uncommon to have many hams call in 50 to 100 cycles off frequency. However, a review of certain facts might clarify this "excess carrier" situation and prevent uncertain hams from getting overly excited if some lid gives them a "you've got carrier" report.

First, all rigs have carrier. It is impossible to get rid of carrier completely. Even a very, very good rig will consistently have an actual carrier suppression factor of only about 40 db and this will vary over normal environmental condition changes. If the final CW power output capability of such a rig is 1 KW, the residual carrier is at least 100 milliwatts of *rf*. That's over twice the *rf* power *output* of a CB handi-talky which has a range of many miles if put into a ham antenna. Obviously, persons in the same city or nearby cities will hear "carrier" between words and phrases. The reason is simple. The AGC of most rigs will make all signals from S1 to 40 over S9 about equally loud in the speaker. This is because AGC is derived from the audio instead of *if* signal. The KW rig across town is going to boom in at about 20 over S9. Therefore, his -40 db carrier is going to be about S7, which will create quite a noise in a mistuned SB receiver. (Each S unit is about 6 db.) The solution to the annoyance of such a residual carrier is to learn to tune the receiver. Complaining to the station operator won't help any because, believe me, he isn't about to replace his crystal filters at their high price. The above case is rather obvious, so let's take a more typical case – one with 30 db carrier suppression, which is still not a sloppy rig. Thirty db is far more carrier suppression than is necessary to get all the signal-to-noise improvement which SSB has to offer. Twenty db suppression is all that most SSB filter manufacturers will guarantee, and a balanced mixer can give from 10 db to 30 db more carrier suppression, depending on degree of balance, voltage, temperature and vibration. In commercial gear, balance is not always too stable over environmental extremes. Therefore, it is reasonable to expect carrier suppression to run as low as 30 db on perfectly normal rigs.

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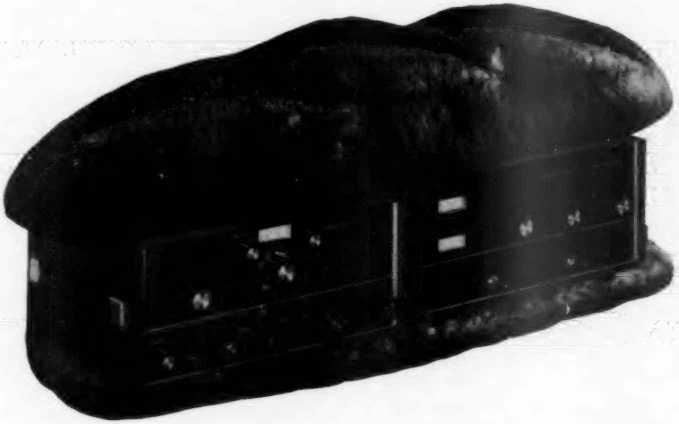

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milliwatts of carrier. One hundred MW of CW on most bands will go a long way. In fact, 30 db is only 5 S units less powerful than the 100 watt signal itself. So, if the fellow with a 30 db carrier rejection rig (and there are lots of them) is putting in an S8 signal for instance, his carrier is going to be about S3. Most SSB receivers will give out the same audio level for an S3 signal as they give for any stronger signal, courtesy of their good audio derived AGC systems. Consequently, between phrases the carrier simply has to be there; and if the receiver is off-tune, it will boil through quite noticeably. That adequately makes the point. The solution is not in complaints about "carrier" but in acquiring a little more skill in tuning an SSB receiver.

Now, what if you do have carrier? Well, that's easy enough to tell from your plate meter reading. You don't have to depend upon listener reports exclusively. With an exciter, when you push the talk button and cover the mike with your hand to keep out room sounds, the plate meter (usually the S meter) reads PA idling current. In a normal rig with no audio input, only two things are likely to make this current higher than it should be. These are too little PA grid bias, which is adjustable by pot on almost all exciters, or carrier leakage.

So, a knowledgeable ham glances at his plate ammeter occasionally and notices whether his PA is idling at about the current it should have. If current is high, he will look for bias drift or carrier leakage. But if the plate current is okay, he will take any "carrier" reports with a large grain of salt. For a very unfounded complaint he may even counterattack with a "poor audio fidelity" report to even things up.

If you have a linear it is very simple to tell whether the exciter is putting out excessive carrier. The idling plate current is quite low on most linear amplifiers. For instance, on my linear, a Gonset 201, the idling current is 50 ma. Full 1 KW CW current is 650 ma. Suppose the linear idling current, with exciter in the receive position, is 50 ma and the current rises to 60 ma with the push to talk button on, but with no noise going into the mike. The amount of carrier leakage is defined by this slight idling current increase. The 1 KW output corresponds to roughly 600 ma of plate current increase. Thus, 10 ma of increase is one-sixtieth as much as full output. The plate current of a linear is fairly proportional to power output because linears have pretty good voltage regulation in the plate supply. Therefore, any additional *rf* output takes a proprotional dc current input. The increase in plate current can be used as a handy indicator of power being put out by the linear after it is tuned up.

The carrier leakage in the example given is about one-sixtieth of a full KW output or about sixteen watts, which is not good. Carrier leakage should not be above ten watts with a KW rig even for a 20 db carrier suppression exciter. So, 60 ma on the rig would mean real trouble. In actual practice the plate current changes about 1/2 ma, meaning I have ½/600 of 1 KW or about 1 watt of carrier which is -30 db. This agrees pretty well with a spectrum analyzer reading of 35 db carrier suppression. The manufacturer claims 45 db suppression but that is at one voltage, temperature, and pot setting.

Therefore, we have seen how your plate meter on a linear tells you what carrier is going out. Of course, it is possible if you have just fixed up the rig that the bias has shifted in the linear to cause a higher plate current at idle, but if you concern yourself only with the change in linear amplifier current as the PTT button is pressed, bias drift won't foul you up.

If you have only an exciter, without linear, bias drift can only be distinguished from carrier leakage by pulling out the tube which drives the final amplifier. With the tube out, no carrier can reach the final, so the plate meter must read just the idling current without carrier. Note the reading and replace the tube to see if there is any change in idling current. If so, use the method just given to estimate the fraction of full power leaking through. By this simple technique you can tell whether you have excessive carrier for your rig easily enough, and you won't need to be needled about it by listeners. Listeners may do well also to bear in mind that not everyone has the same quality rig. Ham radio is a hobby, and it shouldn't be made unpleasant by a few immature hams who think perfect carrier rejection or perfect audio fidelity or perfect VSWR is something very desirable. The most desirable goal is *enough* carrier rejection to do the job intended without wasteful over design or needless time wasted achieving the last few percent of perfection. The same goes for VSWR and fidelity; and some of the hams who complain about fidelity and boast of their expensive microphones are really uninformed. Anyone who tries for high fidelity through a 2 KC SSB *if* filter might also try to build a ladder to reach the moon. I get unsolicited comments on good audio quality using a $1.99 ceramic mike cartridge, simply because even a cheap mike is about as good as a 2 KC receiver *if* is capable of reproducing. The old AM boys who try to get fidelity out of SSB rigs like they used to get out of 10 or 15 KC bandwidths are kidding themselves. That, however, is another story which I'll set a pen to one day soon.

In summary, this discussion has reviewed the facts about real carrier suppression values versus manufacturers' claims; also, ways to judge whether your carrier leakage is excessive were reviewed. It is hoped that frank discussions such as this one will cause those picky hams, who by nature must find a little fault, to realize they are on shaky technical ground when they complain about moderate carrier suppression on a signal. This is especially so if they are not very far from the transmitter involved. Also, the fact that a complaint of carrier leakage automatically means the complainant's receiver is pretty well off frequency will remove the psychological air of superiority involved in such situations, which in itself should go far toward reducing the frequency of occurrence. The unspoken thought that "maybe I can't get my carrier suppressed completely but then you can't tune your receiver either" could go a long way to keep complaints to a minimum unless there is a real need for one.

. . . W4NVK

A HANDY SUGGESTION TO KEEP WIRE NEAT

A simple solution to the problem of reaching for an odd length of wire or test leads and jumpers only to find them tangled up with each other came to mind recently.

The cardboard tubes from toilet tissue rolls are what I use. The pieces of wire are simply coiled and shoved into the tubes which can then be put into a box or drawer without the usual tangled mess that usually results. This method also works well with excess power lead lengths which may be behind the operating desk.

. . . R. A. Watson W1ZOA

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Bandswitching the Swan-250 and TV-2

I sure was anxious to try out my newly-acquired TV-2 two-meter transmitting/receiving converter. Considering that I had to (1) drive back from York, Pennsylvania, to Washington, D. C., (2) make the necessary modifications to the Swan-250 six-meter SSB rig, (3) take one side off my operating bench which was ¼ inch narrower than the transceiver/power-supply/converter combination, and (4) actually make the necessary connections, I guess I did pretty good in being operational on two meter SSB by 2:00 a. m.

Unfortunately, there isn't much two meter activity (SSB or anything else) at 2:00 a. m. on a Monday. After ascertaining that the gadget was, in fact, receiving 145 to 145.5 mhz and putting out an upper sideband signal in the same range, I said to myself, "Now I'll switch back to six meters and see who's still up." It was then I discovered there are lots of knobs and things on a TV-2 converter, but a switch to get back to six meters isn't one of them! I went to bed, thinking I must have missed something, but a quick look at the TV-2 manual the next morning confirmed that it was not I, but the Swan Company, who had missed something–it is necessary to undo and re-do a couple of coax fittings and some Jones plugs to change bands.

Now maybe some operators are content to spend five minutes changing from two meters to six meters, or vice versa, but K3LNZ isn't one of them, even discounting the difficulty of starting a 12-pin Jones plug with 800 volts on it by Braille only–or the equally disgusting alternative of unplugging the doggone gear and removing logs, pencils, mike, etc. from the operating table so that the equipment could be pulled forward. Accordingly, plans were laid to install the band-switching capability the manufacturer unaccountably left out.

Quite a bit of time was spent discovering that it was impossible to modify only the TV-2. For those who want to know why not, let me point out that the 12-volt dc relay supply will not accomodate any more drain; in fact the TV-2 plus the 250 is too much if the line voltage drops to as much as a volt or two below normal. Were the exciter B+ not routed through 3 separate wires in the cable (7, 9 and 10), 110 volts could be

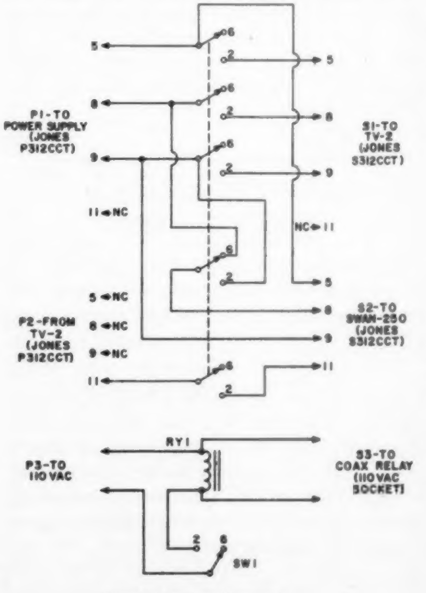
5
6
2
5
8
6
2
8
P1-TO POWER SUPPLY (JONES P312CCT)
9
6
2
9
S1-TO TV-2 (JONES S312CCT)
11 NC
NC 11
6
2
5
5 NC
8
P2-FROM TV-2 (JONES P312CCT)
8 NC
9
S2-TO SWAN-250 (JONES S312CCT)
9 NC
11
6
2
11
RY1
P3-TO 110 VAC
S3-TO COAX RELAY (110 VAC SOCKET)
2
6
SW1

Fig. 1. Wiring diagram.

brought down the cable from the power supply for relay-operating purposes, but this would involve modification of something beside the TV-2.

The final decision to build an outboard unit was based then on three factors (1) retaining interchangeability, (2) somebody else might build such a unit if they knew it wouldn't affect that old bugaboo, "re-sale value," and finally, (3) I could sell the article to 73 more readily.

Actual construction is quite simple, once it is determined that 8 of the 12 wires in the power cables can be ignored in working out a band-switching arrangement. So, get a chassis, a relay wifh a 110 v ac coil and the contacts to break one connection and complete five when energized, an SPST switch, two each Jones P312CCT plugs and S312CCT sockets, a 110 v ac chassis-mounted receptacle, about five feet of 12-wire cable, some terminal strips, and start building.

First, mount a Jones plug or socket on one end of each of four sections of 12-wire cable. Keep track of which color goes to which pin, and make them all the same, using heavier wires and/or extra wires (if available) on pins 4, 5 and 6 which carry low voltage at relatively high current. Bring the opposite ends of the cable sections through rubber grommets into the chassis. Connect all #1 wires together on the same lug of a terminal strip. Do the same with all #2, 3, 4, 6, 7, 10 and 12 (in other words, all except 5, 8, 9 and 11). Now wire the remaining four wires as per **Fig. 1**,noting that RY1 is energized when switching *to two* meters *from six* meters. Finish off by wiring up SW1 and S3 to provide 110 v ac to the coax relay socket, S3 at the same time RY1 is energized.

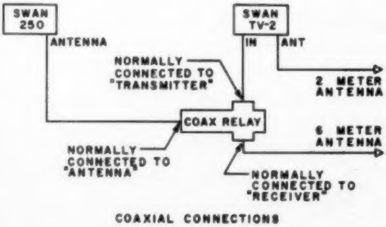
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Fig. 2. Coaxial connections.

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Temple Terrace, Fla. 33617

Remove the normal cabling between the power supply, transceiver and TV-2, and plug in via the adaptor, as shown in Fig. 1. A check at this point will show (assuming you were on two meters) normal operation on 2 with SW1 closed, and normal receiving but not transmitting (check this only briefly) with SW1 in the six meter (open) position.

Now connect up that old coaxial relay left over from AM days as per **Fig. 2**, which will route the output of the 250 into the six meter antenna for six meter operation, and into the TV-2 for two meter operation. In addition, a *Dow-Key* or other good relay will short the six meter antenna to ground during two meter operation, preventing six meter signals from over-riding those on two while listening, or stray six meter signals being transmitted while transmitting on two.

Another sore spot, on the 250 (with or without the TV-2), is the necessity to hold a push-to-talk switch while talking. Since I like to throw a switch and have my hands free (such as for logging contests), I made one more small modification which can be made to any 250 in which there is no crystal calibrator. Examination of the schematic will show a contact on SW2 which is grounded in the *calibrate* position. (This is the one that shows a lead going to Pin 7 of the 12BA6 calibrator, but actually is unused when the calibrator has not been installed.) Running one wire from this contact to the "tip" contact on the microphone jack, J3, will result in the 250 going to full transmit when SW2 is thrown to calibrate. Thus, SW2, ptt or vox will put the 250 on the air, as you please.

. . . K3LNZ

Glen Thomas W5INU
10207 East 6th Street
Tulsa, OK

Cheap and Easy Selectivity

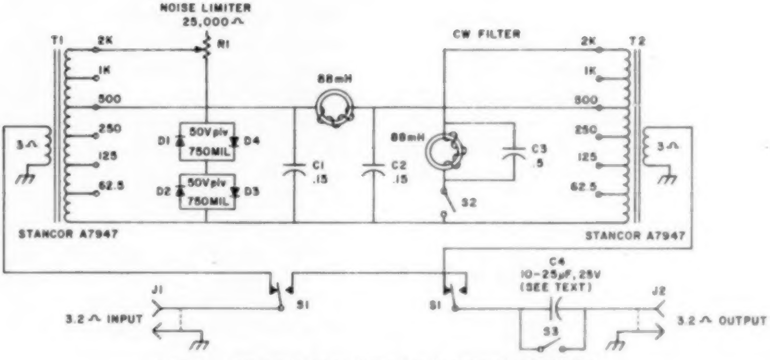
NOISE LIMITER
25,000 Ω
R1
T1
2K
1K
500
250
125
62.5
3 Ω
D1
D2
50V piv
750MIL
D4
D3
88mH
C1
.15
C2
.15
CW FILTER
88mH
C3
.5
S2
T2
STANCOR A7947
STANCOR A7947
C4
10-25µF, 25V
(SEE TEXT)
J1
3.2 Ω INPUT
S1
S1
S3
J2
3.2 Ω OUTPUT

Fig. 1. Circuit for the filter for improved selectivity.

A new receiver was purchased for this QTH about eighteen months ago. It was a big improvement over the much used RME-69 which had served so faithfully over the years. After a few weeks of use, it seemed a little more selectivity would be nice. Not wanting to add an outboard *if* filter or a Q multiplier, an investigation of audio selectivity was begun. This meant digging in all the back issues of radio magazines I could find.

A short article by W6SA1[1] was found along with several other ideas. The result is the filter I am now using with my SX130[2]. The capacitor C4 can be anything from 10-25 mfd depending on your ear. Hallicrafters uses 25 mfd. If you are using a Hallicrafter R48A speaker capacitor, C4 may be omitted as the speaker has one in the 3.2 ohm lead.

The high frequency response cuts off rapidly above 2000 and below 400 hz when C4 is in the circuit. The CW filter peaks sharply at about 1000 hz. Fig. 1 is the filter I am using. A simpler one is shown in Fig. 2

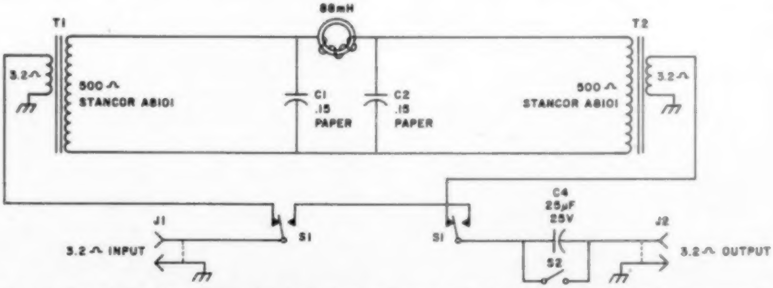
T1
88mH
T2
3.2 Ω
500 Ω
STANCOR A8101
C1
.15
PAPER
C2
.15
PAPER
500 Ω
STANCOR A8101
3.2 Ω
C4
25µF
25V
J1
3.2 Ω INPUT
S1
S1
S2
J2
3.2 Ω OUTPUT

Fig. 2. This filter circuit was also used, and, although simpler in design, produced good results.

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which worked very well.

The CW filter won't work so well on 500 ohms as it will at 2000 ohms or above. If the CW filter is included, it is suggested the output transformer is a multitap one from 500 to at least 2000 ohms. The CW filter is connected to the 2000 ohm or higher tap.

Most of the time the filter is left in the speaker circuit, but the noise limiter is seldom used because the filter does such a good job of taking out the sounds outside the middle audio range. A very worthwhile improvement is the 5 x 130 which was noted when the 6BE6 in the product detector was replaced with a 6BY6.

This is about the easiest way I know of to get more selectivity without digging into your receiver or spending the week's grocery money (less than $10). The results in my case were much better than I had ever hoped for; in fact, this little building project was one of my more successful ventures.

. . . W5INU

Notes

1. 73, February, 1965, p.71.
2. 73, June, 1962, p.36. Hallicrafter R48 speaker.

TOROID CORES

Red "E" Cores-500 kHz to 30 MHz- $\mu = 10$

#	OD	ID	H	EACH
T-200-2	2.00"	1.25"	.55"	$3.00
T-94-2	.94	.56	.31	.75
T-80-2	.80	.50	.25	.60
T-68-2	.68	.37	.19	.50
T-50-2	.50	.30	.19	.45
T-37-2	.37	.21	.12	.40
T-25-2	.25	.12	.09	.30
T-12-2	.125	.06	.05	.25
Yellow "SF" Cores-10 MHz to 90 MHz- $\mu = 8$				
T-94-6	.94	.56	.31	.95
T-80-6	.80	.50	.25	.80
T-68-6	.68	.37	.19	.65
T-50-6	.50	.30	.19	.50
T-25-6	.25	.12	.09	.35
T-12-6	.125	.06	.05	.25
Black "W" Cores-30 MHz to 200 MHz- = 7				
T-50-10	.50	.30	.19	.60
T-37-10	.37	.21	.12	.45
T-25-10	.25	.12	.09	.40
T-12-10	.125	.06	.05	.25

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VHF-FM-Part III

Hand Held Portables

The abundance of portables is one of the strongest points for FM. In time of emergency, you need not be connected with commercial power in any way, thus giving operation in the most extreme conditions. If you have access to a repeater, one unit could be your portable, mobile, and base station. If the repeater is out of commission during the emergency, you had better be able to go "direct" for maximum reliability.

The usual FM portable is quite different from the usual 100 mw 11 meter rig. When a C.B. walkie-talkie weighs, say 16 oz., a common FM portable may weigh over 16 lbs. (yes, lbs.). As for power, FM portables seldom run under one-watt or over five-watts output. The rigs are either in packset form (hand-held unit at waist level with external mike) or if you've got the money, a single hand-held unit like the 27 mhz type. Power is often supplied by Nickel-Cadmium (ni–cad) batteries. The price of the unit itself is. brought up with ni-cads over dry batteries, but the savings in buying new batteries overcomes this.

The care of ni-cads is an art in itself. One can easily ruin one of these batteries. Before you even turn the unit on for the first time, you should become very familiar with ni-cads with regards to charging, discharging, and storage. With used ni-cads running up to $15 and new batteries going for around $65, you can't afford to destroy them! You do not have to use ni-cads with many of these rigs, however. You can use Mercury, Alkaline, and the common Carbon-Zinc battery, but they just do not respond to charging and over-all life as well as the ni-cad. With proper care, the ni-cad should last indefinately.

In general about packsets–these can also come with telephone-type hand sets as well as the standard external mike and internal speaker. Also, when planning to purchase any recent vintage portable, you can count on getting one with a narrow-band receiver. With transmitters, you can usually select wide or narrow-band operation by merely adjusting the deviation pot, while receivers will require a fair amount of conversion.

Following are descriptions of just a few of the more popular portables. Since 2 meters is where most FM is, we will discuss high–band gear. In most cases, however, there is a 6 meter rig with fairly similar specs. **MOTOROLA FPTRU-1 AND FHTRU-1**: These are two old "war horses" which are entirely made of modular tube construction. If unconverted, these should be avoided unless you have plenty of time. Due to their age, these are sometimes in poor condition. **MOTOROLA P-33**: Production was stopped around 1965. These have quick heating tubes in the transmitter. Some have a partly transistorized receiver (P-33 AAM) while others have an entirely transistorized receiver (P-33 BAM). Receiver sensitivity is 1μv and 0.35 μv with an FET pre-amp. One side note... to install an FET pre-amp in this unit all you need is a 3N128. You put this FET between two tuned front-end stages already in the unit and that's it. . .no additional components needed! (thanks to W1RYL for this information). Power output is 5 watts with a 2E24 in the final. Power can come from ni-cads, dry batteries, your car's 12 vdc ignition system or other external source. When not running on internal batteries, be sure that the unit is getting exactly 12 vdc the transmitter has three 6397's as the driver (look up the price on one of these some time) and it has been found, the hard way, that these will blow if the power supply is not giving the correct potential. The weight of the unit with ni-cads is 18 lbs. Electrically, the P-33 can compare with a Gonset Communicator I, II, or III as well as other 2 meter transceivers. You can get a P-33 BAM for about $80 less ni-cads and as-is. Ready-to-go units go for around $140. **MOTOROLA H-23**: same as P-33, but one-watt and 12 lbs. with ni-cads. Price : about $65 less ni-cads and as is;

$125 ready-to-go. **MOTOROLA H-23 DEN (DCN) or HT-200**: These rigs are the same units, but the names are different. The HT-200, as it is now called by Motorola, can come with 1.4 or 2 watts, remote speaker and mike, and Private Line (continuous tone squelch). If you wish, the antenna can be built into the mike cable! Receiver sensitivity is 0.5 μv, with the weight of the unit varying between 32 and 38 oz. This unit can also come in a 450 mhz version for use in a "down-link, up-link" repeater set-up. The entire unit is hand-held like a CB rig with the size varying between the size of 3 to 4 packs of cigarettes. Needless to say this unit is in great demand. You might obtain a used unit for about $200. **MOTOROLA PT-200**: This unit is a new breed of P-33's which can come in either 2 or 5 watts. The transistorized unit has a receiver sensitivity of 0.2 μf with an FET. Weight: just 5 lbs. If you can find a source, the price used is about $225. **G.E. VOICE COMMANDER SERIES**: These are quite popular because they are light weight, small and are not as expensive as one might imagine. They weigh roughly 5 lbs., and are about the size of the Handbook. One watt out is about what to expect for power. The Voice Commanders can be used with dry batteries or ni-cads, with ni-cad chargers going for about $10. Receiver sensitivity is about 0.35 μv with a pre-amp. There are three types of Voice Commanders: **VOICE COMMANDER I**: This version has tubes in the final but the rest of the unit is transistorized. The speaker and mike are built into the case so you have to talk right into the unit. The standard supplier will want about $75 for this unit with ni-cads. **VOICE COMMANDER II**: This unit is fully transistorized, but you still have to talk into the rather large case using two hands. The price is about $100. **VOICE COMMANDER III**: This unit is fully transistorized like the above, but it has a provision for an external PTT mike and speaker. The Voice Commander III very often comes with a built in pre-amp. This version is hard to find as surplus. With the new unit going for about $700, $175 is about what to expect used with ni-cads.

. . .WB2AEB

RG 196 AU 50 ohm teflon coaxial cable. Outside diameter .080" RF loss .29 db per foot at 400 Mhz. Silver plated shielding and conductor. Used for internal chassis wiring, antenna coupling, RF coupling between stages, etc. Random lengths from 35 foot to 150 foot. Colors: black, red, brown, blue, grey, orange. Regular price- 23¢ per foot. Our price 5¢ per foot $3.00 per 100 ft.

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# T-2 This toroid was designed for use in a hybrid F.M. mobile unit, using a single 8647 tube in the RF amp. for 30 watts output. Schematic included. 12 VDC pri. using 2N1554's or equivalent. Sec. #1 500 volts DC out at 70 watts. Sec. #2 -65 volts DC bias. Sec. #3 1.2 volts AC for filament of 8647 tube. Sec. #4 C/T feed back winding for 2N1554's. 1¼" thick. 2⅝" dia. $2.98 ea. -2 for $5.00

# T-3 Has a powderd iron core and is built like a TV fly back transformer. Operates at about 800 CPS. 12V DC Pri. using 2N442's or equivalent. DC output of V/DBLR 475 volts 90 watts. C/T feed back winding for 2N442's $2.95 ea. -2 for $5.00

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P-10 117 VAC Pri. Sec. #1 960 VAC C.T. @ 160 ma. Sec. #2 425 VAC C.T. and tap at 100 VAC 10 ma Bias. Sec. #3 12.6 VAC @ 4.5A Double Shell Mail Box type. Wt. 8½ lbs. $3.75

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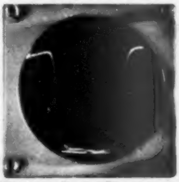
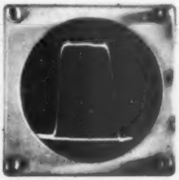


Return Loss Response



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Sunspots And The Ham

Frank MacHovec WB2VFX
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Chester NJ 07930

One of the most interesting occurrences on the sun's surface is the appearance and disappearance of dark spots known as sunspots. These dark areas range from 500 to 50,000 miles in diameter, and generally occur in pairs. They appear dark since they are much cooler than the solar surface they hover over (3000° K compared to 6000° K on the surface[1]). The life span of a sunspot can range from several hours to as long as 18 months, but the average life span is about one week. Sunspots occur singly or in groups ranging in number from two to over one hundred. Groups generally have a large leader spot toward the west and nearer the solar equator which generally lasts longer than its companion spots.

The number of sunspots varies from year to year, but generally reaches a peak every eleven years. The average period between minima[2] is eleven years, but cycles have varied from about 8.5 to about 14 years. Sunspot cycles with numbers over one hundred (like the present one) generally have a 10.7 year period between maxima and minima, rise for 3.5 years, and decline for 7.2 years. Lesser number cycles have an 11.08 year period between maxima and minima, rise for 4.94 years, and decline for 6.14 years. The cycles with higher sunspot numbers generally rise more rapidly and decline more slowly than cycles with lower sunspot numbers.

The number of sunspots is determined by the following formula:

$$\text{Number} = k(10g + n)$$

where g is the number of groups observed, n is the number of individual spots observed within the groups. K is a constant determined for each telescope, which gives results in accordance with the calculations of the Zurich Observatory. This formula was developed years ago by Rudolf Wolf of the Zurich Observatory. Before his death in 1893, Wolf had determined the sunspot numbers back to 1749 and the years of maxima and minima back to 1610.

Sunspots have strong magnetic fields. The strength of the magnetic field is related to sunspot size since larger spots have fields of about 3500 gauss [3], and smaller ones have fields of about 100 gauss. The magnetic polarity of the leader spot is almost invariably opposite to that of the follower spots. about 150. Several dips occur in the critical grequency (foF_2) curve after the 150 sunspot number. F_2 reflection is highly dependent upon sunspot number. Both the muf and foF_2 reach their peak at the peak of the 11 year sunspot cycle.

The Sporadic E layer, which is important to ten, six, and two meter operators, is an area of patchy ionization[5] about 50 miles up. The upper frequency limit for E reflection is not known, but Sporadic E skip has occurred as high as 144 mhz. The critical frequency for the E layer can be determined by the following formula:

$$foE = 0.9[(180 + 1.44\ R)\cos x]^{0.25}$$

where R is the Zurich sunspot number. The exponent varies slightly, but 0.25 is a good value for amateur use. X is the solar zenith angle[6]. This formula will give results within 0.2 mhz of the observed frequencies.[7] The Sporadic E layer, like the F_2 layer, has its muf peak and foE peak at the peak of the eleven year sunspot cycle.

The eleven year sunspot cycle is very important to every amateur radio operator because of the way if influences propaga-

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It is interesting to note that leader spots in the northern solar hemisphere usually have opposite polarity to southern hemisphere leader spots. Many exceptions occur to these magnetic properties, but the information is based on statistical results with a high verification probability.

Sunspots have a profound effect on propagation in the amateur bands. The atmospheric layers which play predominant roles in amateur communications are the F_2 and Sporadic E layers. Most contacts on the bands below 28 mhz are the result of F_2 layer reflection. Sporadic E layer reflection is important for 28 mhz short skip (up to about 2500 miles with multi-hop), skip on 50 mhz (distances comparable to those on ten meters), and occasional long distance openings on the 144 mhz band.

The F_2 layer, which is about 200 miles up, is influenced by solar activity. The highest frequencies are reflected at the peak of the sunspot cycle (50 mhz is often reached). Depending upon solar activity, the muf (maximum usable frequency for reflection) can go as high as 60 mhz or rarely reach 28 mhz. The critical frequency[4] rises in direct relation to sunspot number up to tion. At the peak of the cycle 80 and 40 meters can be nearly useless, but the higher frequencies (20 to 10, occasionally 6 and 2 meters) reach their DX peaks. At sunspot minimum the reverse can be true–80 and 40 become useful and the higher frequencies are useless. With a basic knowledge of sunspots and their effects upon propagation, the ham can choose the correct band for DXing or local work on any day.

. . . . WB2VFX

Notes

1. K° are degrees on the Kelvin scale of absolute temperature on which 0° is equal to -459.4° Fahrenheit.
2. Minima refers to minimum points, maxima refers to maximum points.
3. The gauss is the unit of magnetic induction.
4. Critical frequency refers to the frequency at which vertically transmitted signals fail to reflect back to the point of transmission.
5. Ionization is the process of removing electrons from atoms by the action of solar radiation.
6. Solar zenith angle is the angle formed by the sun's rays and a line perpendicular to the ground.
7. The formula gives the critical frequency for the E layer. The muf and critical frequency for Sporadic E (foE_s) can be much higher than the observed values for the E layer.

Art Backman SM0BUO
Ibsengatan, 44
S-16159 Bromma, Sweden

SSTV

A Taped Lecture delivered at the Congrès International de Télévision d'Amateur, Armentières, France, 1969.

Gentlemen, greetings from Sweden.

I am very pleased to have the opportunity to inform the participants of the international amateur television congress at Armentieres about the slow-scan television activity in Sweden and slow-scan TV in general.

We are today four amateurs in this country who have complete slow-scan TV equipment, namely SM3BCV, SM5CMM, SM5DAJ, and myself.

The possibility of being able also to see the fellow at the other end has certainly caught the imagination of many amateurs, and the longer the distance that can be covered the more exciting it is.

I became interested in SSTV in the end of 1967 and soon got a monitor working. After some weekends of patient listening I succeeded to monitor and record on tape transmissions on the American SSTV-net on 20 meters. That did it, and now I became really fascinated and started to build my first slow-scan camera.

Those of you who have followed the activity of narrow-band television know that the system in use is a compromise between three interrelated factors; namely, bandwidth, transmission time per frame and picture detail. The SSTV-signal can principally be described as a voltage-controlled subcarrier of 1500 hz that is periodically shifted down to 1200 hz for sync-information and then is varied from 1500 hz to 2300 hz for video information. 1500 hz is black, and 2300 hz is top white. The occupied bandwidth is about 2500 hz, and it takes 8 seconds to transmit one picture. The pictures have a resolution of about 120 lines in horizontal and vertical direction.

A few words about the system parameters: In general, the greater the deviation in an FM-system, the better the signal-to-noise ratio in the presence of a given amount of interference. The maximum allowable deviation is determined by the bandwidth available and the maximum modulation frequency. Commercial facsimile operations have standardized on a frequency shift from 1500 to 2300 hz to represent the transition from black to white. When used with radiotelephone equipment having essentially flat response from 1200 to 2500 hz, modulating frequencies from 0 to 900 hz can be reproduced. If the white frequency is made much higher than 2300 hz, it will be attenuated by the audio cut-off characteristics of some transmitters and receivers. If the black frequency is made much lower than 1500 hz, the number of subcarrier alternations per picture element drops to too low a value, and horizontal resolution is lost. 1500 and 2300 hz are therefore adopted as the standard black and white frequencies with shades of gray being represented by frequencies in between.

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as video, a sync frequency of 1200 hz is employed. A horizontal sync pulse is transmitted as a 5-millisecond burst of 1200 hz tone and a vertical sync pulse as a 30-millisecond burst. To permit the transmission of horizontal resolution equivalent to 120 lines, a horizontal sweep rate of 15 hz is selected. To give a 120-line raster a vertical scanning rate of 8 seconds is used.

The sweep frequencies are not at all critical and may be plus or minus 10% or more without seriously affecting the usefulness of the picture. For best results the sync frequency should be kept within 50 hz of 1200 hz. The black and white sub-carrier frequencies may be off 100 hz without causing trouble. A plus or minus 20% tolerance on the sync pulse duration should be all right.

The system can be used with any type of single-sideband equipment. The camera output is simply connected to the microphone input of the transmitter and the monitor to the audio output of the SSB-receiver. An audio tape recorder can be used to advantage for recording or playing back pictures.

This amateur slow-scan television system was developed by Copthorne MacDonald, WA2FLJ, about ten years ago. Today there are about 75 slow-scan amateurs in the United States and Canada.

Because it is impractical for me to describe the slow-scan equipment in detail, it may suffice to mention that the heart of the monitor is a cathode-ray tube with a long persistance screen, such as 5FP7 or 5ADP7. The signal is fed via the input limiter stages and video discriminator to the video amplifier, detector and filter and modulates the beam current of the CRT thereby producing brightness variations. The sync signal is separated in the sync discriminator, is amplified, rectified and used to control triggering of a horizontal and a vertical multivibrator which delivers drive pulses to discharge tubes. Across the load resistor of each discharge tube is generated a sawtooth voltage for the sweep amplifiers.

A slow-scan camera looks very much the same as a conventional fast-scan camera. A horizontal and vertical multivibrator generate sawtooth waveforms and retrace pulses for blanking. To minimize hum-effects, the vidicon beam current is chopped at a 10 khz rate. The signal is amplified in the video amplifier and the output is connected to a modulator which shifts a voltage controlled subcarrier oscillator from 1500 hz to 2300 hz depending on the level of the light falling on the vidicon target plate. Sync signals from the vertical and horizontal oscillators are combined in the sync mixer, and the resultant composite sync signal is connected to the modulator which shifts the subcarrier down to 1200 hz.

Many American amateurs use the Westinghouse 7290 vidicon, which was especially designed for slow-scan. In the camera an electro-mechanical shutter synchronized with the vertical retrace exposes the photoconductive layer of the vidicon for a fraction of a second at the beginning of each frame scan. This exposure establishes charge patterns in the photoconductor that are scanned off by the electron beam. In addition to giving rise to a varying electrical output signal, the beam also erases the previous scene's charge patterns and readies the tube for another exposure. Conventional vidicons act in a similar manner when scanned at 25 frames per second but are unsatisfactory when shuttered and when scan rates are slowed down because the charge patterns leak away too rapidly.

Some amateurs, for instance Ralph Taggart WA2EMC, have proved the possibility of using unshuttered conventional vidicons. My present camera uses the well-known 55875 Plumbicon by Philips, which has a very low dark current at the slow scan rates used. Most conventional vidicons, however, have a too high dark current with these sweep rates, and they are not able to erase immediately the previous picture.

Because of the slow scanning rates, a slow-scan TV camera requires much more time and patience to adjust initially than does a conventional fast-scan camera. With normal TV 25 complete pictures come along every second and one can see the results of an adjustment immediately. Not so with slow-scan TV; one must wait at least eight seconds to see the results of many adjustments.

Because of these disadvantages and the time-consuming setting-up procedure, some amateurs have started designing sampling systems. These consist in short of a normal fast-scan camera, the output of which is sampled to synthesize a slow-scan signal. A normal fast-scan monitor is used to quickly set up the camera for optimum focus and contrast and by the flick of a switch the system is made to work in the slow-scan mode.

One cheap and very simple method to generate very high quality slow-scan pictures should not be overlooked. That is the use of a flying-spot scanner. In this system a raster is produced on the seven centimeter screen of a cathode-ray tube with short persistence. The light from the raster is focused on the transparent photograph to be transmitted, passes a set of condenser lenses and strikes the photocathode of a photomultiplier tube. The optical signal is amplified several thousand times by the photomultiplier and is then fed to the modulator. The rest of the circuits correspond to those of a slow-scan camera.

Here in Sweden, we still operate slow-scan on individual temporary permissions valid for one year at a time. Last year the American FCC and the Canadian Department of Transport authorized slow-scan television for the North American amateurs. For the United States the segments chosen are those which after Nov. 22nd, 1968 are restricted to holders of Advanced and Extra Class licenses, whereas in Canada parts of the phone portions in general are allocated for SSTV.

It is interesting to note some comments by the FCC in its report following the authorization as quoted by QST, Sept., 1968:

> Generally the recommendations for reduced frequency availability or for operation in telegraphy sub-bands were based upon the fear that disruptive or destructive interference to telephony communications would result from narrow-band TV. Since May, 1966, a number of amateur stations throughout the United States have been authorized to transmit slow-scan TV signals for test and demonstration purposes. No cases of interference resulting from these authorizations have been reported to the Commission. Slow-scan TV is more susceptible to interference than is radiotelephony requiring a ratio of desired to undesired signal of 10 db to 20 db for marginal or good picture quality. This requirement would appear to be such that slow-scan TV would generally not be used in the more heavily populated portions of the available frequency bands. Furthermore, there is some evidence that a single-sideband transmitter, operating in the slow-scan TV mode within the same bandwidth as radiotelephony, has less interference potential than the same transmitter using radiotelephony at its rated peak envelope power.

The first transatlantic two-way SSTV contact was established on June 24, 1968 by Syd Horne VE3EGO, in Ottawa, Canada, and SM0BUO in Stockholm, Sweden. Since then many contacts between North America and Sweden have been carried out. My friend, Willy Everaert ON4WM will demonstrate for you, besides SSTV from my own equipment, also tape-recorded transmissions over the air by W4ABY, W2PMV, W9NTP, VE3EGO and WB2LUM. These specific transmissions were made on 28.7 mhz and will give examples of how interference and fading affect the SSTV signal. The transmission from Don Miller W9NTP is of outstanding quality. His signals peaked 30 db over S9 at that time.

It is certainly possible to further improve the transmitting and receiving slow-scan equipments. I hope that with this little lecture some more European amateurs will become slow-scanners and help to create world-wide visual amateur communication.

Note . . . SM0BUO

Information about ATA International may be obtained from Mr. Erik Platteeuw ON4LP, Oude Brusselseweg, 119, Gentbrugge, Belgium.

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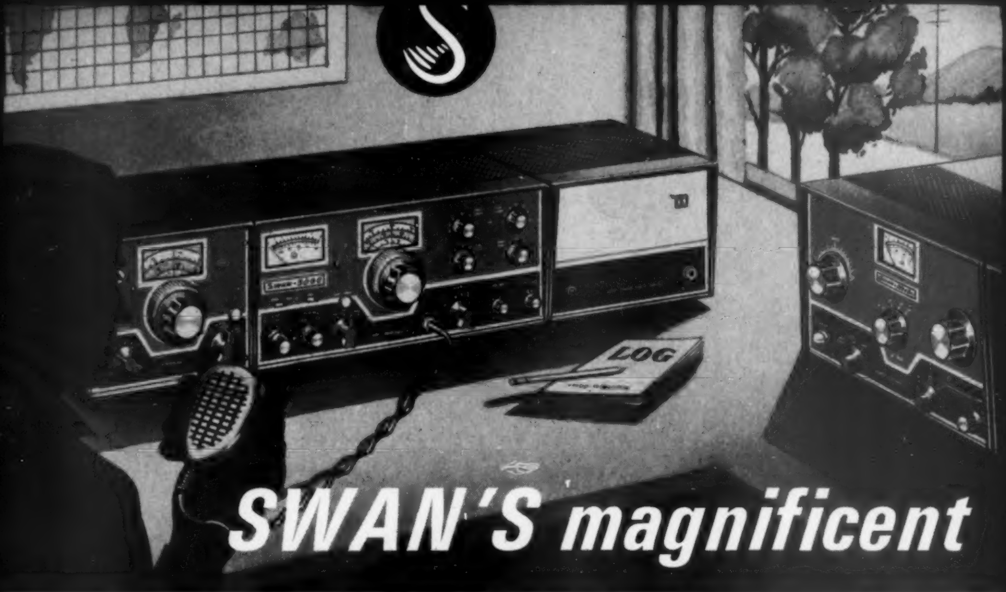

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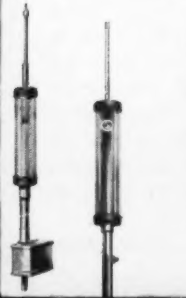

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Amateur Radio in the Classroom

It is becoming increasingly important that amateur radio attract the youth of our nation into its ranks. Many times I have heard amateurs speak of recruiting the students from the junior and senior high school, but very seldom do I hear the phrase, "Let's try to recruit some of the students from the elementary school." While teaching in the elementary school, working with high school students in amateur radio, and presently teaching on the university level, I have had the opportunity to analyze students according to their interests, motivation, and available time. It becomes apparent that students in the upper elementary grades (4, 5, 6) would be very receptive to an amateur radio recruitment program. My objective is to discuss an experience in one of my classrooms and how we might be able to interest more elementary grade children in amateur radio.

Try Ham Radio

When conceiving the idea of taking radio equipment into my sixth-grade class, I did not intend it to be an elementary recruitment program for future hams. It was meant to be an instructional lesson relating the fields of electricity, radio, and the art of communication. My radio was to be a culminating activity with all children having the opportunity to speak to hams in the United States, and hopefully, in another country. What actually happened became one of the happiest and most exciting experiences in my teaching career.

While teaching an instructional unit one day, I mentioned that I would be bringing my amateur radio set into the classroom. A few of the boys had a somewhat foggy idea of what this meant, but the majority of the children had never been exposed to this media of communication. After making the proper arrangements with my principal, who was strongly in favor of the idea, and erecting a multi-band antenna, I set up my transceiver one night after school with the aid of several curious children. That night I spent several hours in my room making sure that all equipment was in perfect operating order. Several parents called the school and wanted to know what was going on in my room. Curiosity was being generated!

The next morning I checked into several nets from my classroom. It was the earliest I had been in the classroom all year. The children started arriving. "What's that?" "Can we listen to some music?" "Is that a ham radio?" I said nothing while trying to build up excitement and interest for the upcoming event. After the typical opening tasks–pledge to the flag, collecting milk money, and making sure all of the children were present–I proceeded to introduce my reading lesson for the day. Wow! The children just would not have that, at least not at this time. So, I decided to tune up the rig and attempt to make contact with some ham in the states. Still no formal introduction had been made of amateur radio. Contact was made with a ham in Minneapolis on 80. This is really nothing for an amateur radio operator living in Minnesota, but it is quite

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an accomplishment to a neophyte. The children were just wild! Questions began to fly! "How does it work?" "May we talk over it?" Finally came the question, "Will you teach us something about that radio?" God bless that student. This was the moment I had been waiting for. Thet now wanted to learn about the subject because their interest had been stimulated.

Rumors mushroomed around the school. Students started coming into the room as early as 7:30 am. One morning there were over thirty-five fifth- and sixth-grade children talking and listening to hams around the country. I did not have to ask them to come. They were motivated by their strong interest and excitement of who would be next to talk into the microphone. Finally, several teachers asked if I would let other children come in and have the opportunity to talk over the radio. Why not! During the next few days over 175 students visited my room with well over 100 having the opportunity to talk. Many did not want to talk and they were not forced into doing so. On the last day of the week while we were making contact with several hams in California, Mexico, and the Canal Zone, a photographer from the local newspaper walked into the room. He, too, had heard of the excitement that had been generated by our radio. A picture and a short write-up telling about amateur radio in our classroom appeared in the next night's edition.

During that week, my class was exposed to new understandings relating to amateur radio. Also, they learned more geographical locations in five days than I had been able to teach them is several previous weeks. Why? Because now they had a purpose in locating and remembering the originating points of various contacts. All in all the week was most exciting.

After the radio was taken home, and the room started to get back into a normal routine, I had time for introspection. This had been one of the happiest moments of my teaching career. I did not have to motivate the children; they were motivated by amateur radio. I did not have to squeeze questions out of the children; they asked question after question because this was something exciting and something about which they wanted to learn. I found that many of the children were actually capable of learning things that I had thought to be too difficult. But, most important, I learned more about my children. They came early in the morning, at noon hour, and stayed late. During these periods we really got to know each other. And most hams would agree that getting to know people and to respect their interests is an important phase of amateur radio.

A SHOCKIN
SU E

Try Ham Radio—A study of communications by the sixth graders of Robert Wood at Washington School was highlighted this week by an actual demonstration of "ham" equipment, owned by Wood, an amateur operator. Wood, shown at right above, looks on while Kim Schumann, 11, son of Mr. and Mrs. Milton F. Schuman, talks into the microphone. Other students in the picture are Denise Link, 11, daughter of Mr. and Mrs. Kenneth Link, and Steven Edgar, 11, son of Mr. and Mrs. William Edgar. During the week the children made contacts with an operator in Mexico, several in California, with a ship passing through the Panama Canal, and numerous contacts throughout the country. Youngsters in other classrooms at Washington visited Wood's room to view the unusual activities. The children also were taught how electricity is related to radio and communication. The bulletin board display in this picture centers around electricity.

(Post-Bulletin Photo)

You Too Can Take Amateur Radio Into the Classroom

After this most enlightening experience, and reading Wayne Green's comments about getting new blood into the amateur radio ranks, I believe the following ideas will serve as a guide for other amateur radio operators to demonstrate their hobby in classrooms, and hopefully, to recruit a few new members.

There is a trend in public school education to enlist the aid of lay people to serve as resource persons to enrich the curriculum.

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This may be the first important step in a planned recruitment campaign. I would recommend the following procedures to one interested in serving in the capacity of a resource person:

1. Contact the person responsible for the instructional program of the school. This person might be the superintendent, an assistant superintendent in charge of curriculum, or maybe the elementary school principal. Tell them what you could offer the teachers while they are presenting a science or social studies unit. Remember, when you are planning at this level, you must emphasize the instructional aspects and how this will aid the education of the child. We hope that we will interest some children to the extent that they will become amateurs, but first let's just expose them to this hobby for fun and enjoyment.

2. If you are the friend of a teacher, offer your services to help her teach a unit on electricity, radio, communications, etc. Again remember, we are trying to provide a service to the teacher. Once teachers find out about a person who is interested in children and education, half of the battle has been won.

Now that some form of initial contact has been made with the people responsible for the instructional program, what should you consider when you are called upon to serve as a resource person?

1. Get in contact with the classroom teacher. You may wish to ask the following questions: What instructional unit are you presently teaching and how will I be able to best serve you in your teaching? What grade level do you teach? How old are the children? Have they had any previous contact with amateur radio? What do you know about amateur radio? Could I give you some material to help prepare yourself as well as the children? Could I come to survey the classroom and area to determine the antenna placement and power outlets? (This could present a problem for some schools.)

2. Remember, the classroom teacher is the person directly responsible for the instruction of the children. Work closely with her and aid her in any way possible. Many teachers do not know about amateur radio and this may be their first contact with it. Expect questions that you may take for granted when it comes to your license, equipment, safety factors, etc. This is the time to remain cool, calm, and collective.

The big day arrives. The proper school contacts have been made; the antennas and equipment may be in place, or, depending upon the time factor, let the children watch you set it up. The children are anticipating the guest speaker who will demonstrate amateur radio. What do you do? How do you act with sixty eyes upon you? The following suggestions may make your first classroom presentation a bit easier:

1. Relax, this will be fun. Your voice has probably been heard by more hams at one time than by those who will hear you today.

2. Watch your vocabulary. These are elementary school children, not electrical engineers; however, don't coo and gurgle with them either.

3. Have your presentation planned. You will probably have only a set amount of time so know what you can do within that time limit.

4. There is an old Chinese proverb that

goes like this:

I hear and I forget . . .
I see and I remember . . .
I do and I understand . . .

Therefore, get the children involved in discussion, and most important, give as many children as possible a chance to speak over the radio. Some will be shy, so don't force them. There will be plenty of little "hams" in the room.

5. Conclude your presentation with the idea that if any of them are interested in learning more about amateur radio, they could call you or make personal contact. Give each student a qsl card.

After your presentation is concluded, equipment taken down, and you are preparing to leave, be sure to thank the teacher, principal, and others directly responsible for giving you the opportunity to demonstrate amateur radio. Today there are many pressure and hobby groups that wish to use the classroom for their own benefit. If we are to expose children to amateur radio, then we must sell the idea of how we can help the teacher and school educate the child. When you are in the school, you are teaching, recruitment of future hams is secondary in nature. If the children are impressed and genuinely interested, they will contact you.

After taking a poll of several elementary school teachers, principals, and superintendents in regard to utilizing amateur radio operators to enrich the school's curriculum, I found that 99.9% of those polled were excited and thought this to be an exceptional learning opportunity for children and teachers alike. Many teachers said they knew nothing about amateur radio but would like to learn more. This is a hobby that I have been engaged in since ninth grade. I wish an amateur radio operator would have visited my elementary classroom so I could have been exposed earlier to this worthwhile hobby!

Now that I am teaching at a university, I have wondered many times about the value of the amateur radio in my classroom. Recently, my ex-principal visited the university on a recruitment trip. According to him, my bulletin boards left something to be desired, but "project ham radio" left a lasting impression.

. . . K0HUD

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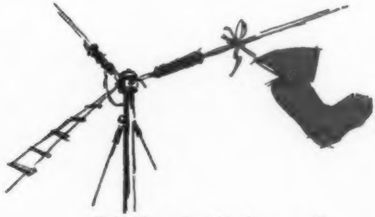

"A Ham's Christmas"

'Twas the night before Christmas, and from the hamshack
Came the warm glow of tubes from the transmitter rack,
The log had been brought up to date with great care
In case the FCC might some day be there.
Harmonics, XYL and all were in bed
(No Tennessee Indians to addle their heads).
I turned on the receiver, set the BFO,
And was just settling down for a long QSO
When up from the yagis arose such a clatter
That I yanked the big switch to see what was the matter.
Then between the dipoles and the Trap-Master beam
Came a loud shout, like a heterodyne scream:
"On, Clegg, Hallicrafters, on Collins and Elmac,
On, Allied and Daystrom, on Johnson and Eimac–
Up the mast clear to the corona ball,
Now dash away, dash away, dash away all!"
Quite suddenly, as I was turning around
Down the waveguide he came with a bound.
His nose was quite round, like an egg insulator;
His cheeks were as red as a hot oscillator.
A new microphone he held tight in his teeth
And coax encircled his head like a wreath.
I peeked from behind as he turned his back–
Was that my name on a new power pack?
He wasted no time, but went straight to his work
And when he had finished, he turned with a jerk;
Then laying a finger aside of his nose,
Saying, "Pse QSL," up the feeders he rose–
But as he departed after leaving the gear
"Merry Christmas to all!" I was able to hear . . .

Karl Beckman WA8NVW

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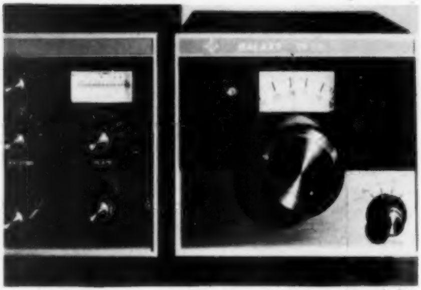
The Galaxy RV-550 Remote VFO



If you are used to operating straight transceive at the home station, you may have become accustomed to the idea that a remote VFO isn't really a must. After all, don't we always work each other on the same frequency? So for operating convenience, isn't transceive the best mode? OK, I figured, it must be nice to be able to work stations in the foreign phone bands, but that was a luxury for the rabid DX hunters. And I *had* made DXCC in the U.S. bands. Who needed split frequency operation?

Just one week of using the RV-550 sure changed my ideas. Now I'm convinced that my station would be only half equipped with the transceiver alone, even if I never worked another DX station.

The Galaxy RV-550 Remote VFO is the natural companion to the GT-550 Transceiver (see 73, page 48, May, 1969) with the same elegant styling. Incorporating the same, four transistor VFO circuit that is a standard-of-comparison in stability, the RV-550 also has the identical 500 khz tuning dial and large spinner knob found on the GT-550. The *only* other control is a four position FUNCTION switch. I emphasize the word only because, unlike some remote VFOs, there is no separate bandswitch control. Whatever band the GT-550 is switched to, so then is the RV-550. No chance of getting the VFO switched to a different band or having to fuss with several VFO segments within the same band. Simple, uncomplicated and a pleasure to use.

In practice the RV-550 adds three useful functions to its parent transceiver, without which its hard to imagine how I got along. The FUNCTION switch gives you these four options at the flick of a wrist:

1) OFF - Just what it says. The RV-550 is inactive (indicated by the dial light being out) and the transceiver operated in its normal mode.
2) REC - Receiver tuning is controlled by the RV-550, while the GT-550 dial sets the transmit frequency.
3) XMIT-REC - The RV-550 controls both receive and transmit tuning in transceive mode, while the transceiver VFO is inactive.
4) XMIT - This is just the reverse of function (2). Transmit frequency is set by the RV-550, while receiver tuning is accomplished with the GT-550 dial.

Very sophisticated, you say, but what do I get out of these several functions?

Well, suppose you are working a net and want to move off the control frequency to pass traffic with another member. He asks, 'where do you want to QSY?' You flip the RV-550 to REC and tune it to find a vacant spot. Switch to OFF, 'OK Chuck, 7275 is clear, I'll call you. Switch to XMIT-REC and you are transceive on the previously selected frequency to call him. And when you finish the traffic, switching the RV-550 to OFF puts you right back on

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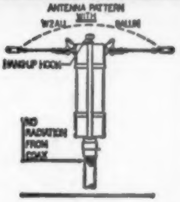
9. **FACTORY ADJUSTED LIGHTNING ARRESTER.** Bleeds Off Heavy Static Charges. Makes For Quieter Listening
10. **BACKED BY 50 YEARS OF ELECTRONIC KNOW-HOW.**

Comes in 2 models. 1:1 matches 50 or 75 ohm unbalanced (coax line) to 50 or 75 ohm balanced load.

4:1 model matches 50 or 75 ohm unbalanced (coax line) to 200 or 300 ohm balanced load.



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the net frequency, set by the transceiver dial. For emergency work you can transceive on two net frequencies, switching between them as the situation requires without touching the tuning knobs. Great for inter-net liaison.

You are not a net man? Well, maybe you have worked one of those nomadic types, destined to wander away up frequency. Tracking him with the transceiver dial means that he won't find you where he left you, and his anguished cries will seemingly go unanswered. Or if he has one of those transceivers with a 1 khz difference between transmit and receive, you both 'bunny-hop' some 10 khz in the course of a few overs, tromping across other QSOs on the way, and leaving a lot of blistered feelings. In either case the REC function is good for holding on to the nomad, while maintaining your transmit frequency stable.

While waiting for that rare DX to wind up his contact with a long-winded W6, you can put the RV-550 on REC to scan for other hot ones, with the capability of going on XMIT-REC to get a quick contact, then to OFF and the original frequency in time to catch the rare one as he gets his last of a string of 73s. Handy for contest flexibility.

If you're wondering what function 4 is good for . . . . .! The VK9 you can copy loud and clear says you are clobbered and begs you QSY up ten, which he finds to be in the clear. A quick check on REC proves this spot is solid QRM at your end. No mind—tell him to stay put, switch to XMIT and tune the RV-550 to the frequency he can hear you.

Hooking up the RV-550 to the GT-550 requires all the time it takes to plug in the two cables supplied, between the units. The GT-550 furnishes the regulated 12VDC. Hardest part is getting the VFO out of its shipping container—those Galaxy packers must be trying to set standards for the I.C.C. when it comes to protecting their wares.

Oh! By the way, the RV-550 is also fine if you are a rabid DXer and want to work the fellows in the foreign phone bands.

. . . W6AJZ

Jim Ashe

Calculation Made a Little Easier

If you have trouble working with numbers and simple calculations in electronics, you have lots of company. The standard American high-school mathematics program comes close to 100% efficiency in producing graduates who cannot avoid having real trouble with even the simplest mathematical calculations. A part of the reason was uncovered a few years back by the American Mathematical Association in a survey which disclosed that better than 50% of high-school math teachers were afraid of mathematics. And that indicates you have probably been exposed, in your formative days, to one or more such teachers. Very unfortunately, fear is contagious.

Probably you have noticed when a man is afraid of something, if he has to work with it, he becomes slow, tense, and cautious. His chances of making a mistake may actually be increased, yet error may be what he most wants to avoid. How about that? Does this resemble your style of doing calculations?

Yet, if you cannot handle even simple math, you suffer under a very considerable handicap. Electronics is a very fine hobby, but it is a better one if you can estimate appropriate component sizes, circuit voltages, signals, and the results of wiring changes. Perhaps you have to compete in your work for promotion, or even for a job, against another person who can handle mathematics better than you can. This can be a terribly serious affair, and very frustrating too. Here are two key ideas that will help you to use mathematics more effectively, and in the rest of the article I will apply these key concepts in several different ways.

My first point is, school mathematics is unnaturally perfect. Teachers, typically, lack engineering or scientific experience, and they draw very sharp lines between "right" answers and "wrong." These differences only rarely exist in real life, yet if you retain these false standards in the back of your mind when you are using figures and equations you may try too hard to avoid error. And, as a result, fall into it.

And the second key point is that mathematics is a practical art. You do not believe that? Then, if you have never thought of it from this perspective look at the instant results obtained by thinking about resistors, capacitors, signals, alternating voltages, antennas, transistors, you name it. The language of electronics, as of the science from which that electronics is derived is mathematics. This fact is only doubtful because of the large amount of purportedly technical electronics study material presented "without that math jazz." The man who has mastered this kind of learning comes to an instant halt when asked to design even a simple circuit, and will frequently make only slow progress when required to service a circuit that needs only a little more talent than plugging in tubes.

That's most circuits, nowadays.

Now, About Numbers

Numbers become much easier to work with after we find out something about how they are made up. They are quite interesting and some people become extremely enthusiastic experimenters, working with pencil and paper to discover new things about numbers.

1
2
3
4 USE TERMS
5 "DIGIT" OR "INTEGER"
6
7
8
9

10 INTEGER TEN, COMPOSED OF DIGITS ONE AND ZERO
⋮
372 INTEGER THREE HUNDRED SEVENTY TWO, COMPOSED OF DIGITS THREE, SEVEN, AND TWO.

Fig. 1. Terms "digit" and "integer" have same meaning at low end of the number scale, but different meanings for values over nine.

Very often when we are talking about numbers, we use two new words. See **Fig. 1.** These terms enable us to avoid confusions which might arise in saying, for example, "This number is composed of the numbers . . . " Instead, we say, "The integer 456 is composed of the digits four, five, and six." "Number" is a rather nice word in itself but rather general and so I will use the new terms when I need to be accurately descriptive.

14,756 equals	10,000	(ONE TEN-THOUSAND)
	plus 4,000	(FOUR THOUSANDS)
	plus 700	(SEVEN HUNDREDS)
	plus 50	(FIVE TENS)
	plus 6	(SIX UNITS)

Fig. 2. This is how a large value is built of decreasing decimal products. Digit value increases to the left.

Here is a rather sizable number: 14756. This integer is actually a shorthand description of a sum, which I have worked out in **Fig. 2.** Here we discover it consists of a principal part of 10,000 plus assorted smaller parts adding up to a respectable amount in themselves. They make up nearly one-third of the total amount, and could never make up one-half of it. Why is that? Now, since the units, the tens, and maybe even the hundreds, do not add up to much compared to the thousands and ten-thousands, why not drop them off so we can work with a simpler integer when calculating? Engineers do this routinely, and it is called "rounding off."

Sometimes it is convenient to break down integers in another way. This is called factoring, shown in **Fig. 3.** Here we see, for instance, the integer 1758 is obtained by multiplying 2 x 3 x 293. When you have done a lot of numbers work you tend to watch out for this structure since you may be able to find an easier way to do the calculation. Some handbooks contain tables of factors and primes and if you can find such a table perhaps you'll find it surprisingly interesting.

$4 = 2^2 = 2 \times 2$
$114 = 2 \times 3 \times 19$
$247 = 13 \times 19$
$616 = 2^3 \times 7 \times 11$
$1758 = 2 \times 3 \times 293$
1759 is prime
$1760 = 2^5 \times 5 \times 11$

Fig. 3. Most integers are composed of smaller integers taken as a product, but a few "prime" integers are not factorable.

A prime number is one which is not divisible by any smaller number, without something left over. If we divide our 1758 by 2, which goes perfectly into it, the remaining integer is 3 x 293. Then we can divide out the three, leaving the 293. But the 293 is prime, since there is no smaller number we can divide into it without a fractional remainder.

Numbers can become real friends, with some practice. You can learn many things about them, and if you look around you find them in almost everything men do, and in nature too. Many plants grow according to numbers and simple mathematical rules. If you would like to develop some feel for this subject, there is probably no better book available than *How to Calculate Quickly*, by Henry Sticker, from Dover Publications.

Sticker provides a series of step by step exercises, which serve the same purpose as throwing and catching a baseball again and again, just for practice. After a little while you discover a growing feel for what numbers are and do, and they become familiar, reliable friends. Only patience is required. Intelligence has far less to do with it than most people believe.

Rounding Off Numbers

When I have to work out a calculation, my first step is to bring together neatly all the numbers I need to work with. If the calculations are involved the figures go in a handy column at the right hand side of the paper (I'm a southpaw) and maybe I add a few notes on where some of them came from in case I should want to check back later to verify accuracy. But for simple calculations I will usually write the numbers in where I am going to use them. Maybe I look again at one or two of them because I want to be sure they are correct and that I did not transpose digits anywhere. That is, I did not copy 6902 as 6092, for example.

Next, I round off any integers that have too many complicated digits. This will make the calculation much easier. For an example of what you can gain by rounding off integers, see **Fig. 4**. Here I have rounded off two integers by replacing digits with question marks, and we see that rounding off reduced the job of multiplication by better than half. It reduces the possibility of error, too, and improves the chance that when you make an error (and we all do) it will be easier to find, and you may even spot it immediately after you goof.

```
      1.2 ? ?
    x 1.2 ? ?
    ---------
      ? ? ? ?
    ? ? ? ?
  2 4 ? ?
1 2 ? ?
-------------
1.4 ? ? ? ? ?
```

Fig. 4. Replacing one half the digits in this multiplication problem has reduced the work by more than half. If we removed uncertain or unnecessary digits in this way, there would be no loss of accuracy for practical purposes.

Now let's think about a familiar number, often used. Some well-intentioned but not very mathematical state legislator once proposed a law making pi exactly equal to three. I read about this in the writings of a man who felt the idea was pretty ridiculous since pi is a natural number, which the mathematicians call a non-terminating decimal. As originally proposed the idea *is* ridiculous, but it also started me writing this article, and now we are going to take a second, practical look at it. What does this do to the accuracy of our calculation if we go ahead and use this pi equals three value?

It's instantly clear a calculation with a 3 in it will be far easier to do than the same calculation using a 3.14159 . . . And if we work out the percentage error this modification introduces, we discover it brings in a minus 4.5% error. Since we conventionally use 10% or even 20% components, we can usually ignore that 4.5% error and avoid some useless work. Now let's go into the ideas behind rounding-off numbers. A little knowledge can be a dangerous thing, you know.

Looking back at **Fig. 2** we see that some digits are more "significant" than others. The left-hand digit, representing ten-thousands, carries far more of the total value of the integer than does the hundreds digit. This key point, taken with some thoughts about error and percentage accuracy, enables us to work out a practical view of rounding off for electronics calculations. We can round off many significant digits to two and occasionally three, but if we round off to one significant digit we often generate unacceptable error. Sample calculations in **Fig. 5.**

Original integer	Rounded integer	Percent error
1.1	1	-10%
1.4	1	-29%
1.5	2	+33%
1.6	2	+25%
1.9	2	+5.3%
2.1	2	-4.8%
2.5	2	-20%
5.1	5	-2%
5.5	6	+8.3%
9.5	10	+5.3%
9.9	10	+1%

Fig. 5A.

Original integer	Rounded integer	Percent error
1.11	1.1	-0.9%
1.14	1.1	-3.5%
1.15	1.2	+4.3%
1.16	1.2	+3.4%
1.19	1.2	+0.8%

Fig. 5B.

Fig. 5. The effects of rounding off depend on the change in effective size of the integer. Rounding off two digits to one as in 5A will often introduce sizable errors. Rounding three digits to two can never introduce more than 4.3% error.

The best case of rounding off two significant digits to one is rounding 9.9 to 10, or 9.1 to 9, and here we find about 1% error introduced. But at the other extreme, if we round off 1.5 to 2 we find a 33% error. The change in value is very great.

But if we are rounding off three digits to two, the very worst possible case is rounding off 1.15 to 2, which introduces a 4.3% error. Any other rounding off 3 digits to two will cause a smaller error. Briefly, we can round off two significant digits to one if the difference is not too great, and we can practically always round off three significant digits to two.

Rounding off is not merely a matter of dropping digits and increasing the remaining RH digit by one if the next digit was a five. See **Fig. 6.** When the next digit is a five, we always terminate the rounded integer with an even digit. This strategy averages rounding errors over many calculations of the same type, and offers the convenience of an even number to work with. Maybe we can factor out the 2 and use it elsewhere.

3.75 — 3.8	5 to be dropped, always round to even integer.
3.85 — 3.8	
3.95 — 4.0	
4.05 — 4.0	

Fig. 6. We always round off to next higher even digit preceding a dropped five.

Standard Notation

Let's review our discussion of rounding off numbers. We can easily reduce any complicated integer to a simpler one, probably consisting of two nonzero digits and a collection of zeroes at one side or the other to fill spaces out to the decimal point. When we use these rounded-off integers in calculations, we work with the nonzero digits, and the zeroes come along to help us find the decimal point's location when the work is done.

Why not separate the nonzero digits – the significant digits – from the rest of the number? Then we could do our calculation with a really minimized effort, and catch up on the zeroes and decimals later. And this would make our calculations more reliable too, since if we could reduce all numbers to significant digits between say one and 10, we would be able to use an intuitive check on the accuracy of our result. For example, if our calculation boiled down to something like 5.4/2.6, we see instantly the result has to be near 2. Is there some way we can do this?

Yes, and it is called "scientific notation." Science is no respecter of human abilities and presents scientists with numbers larger than the mass of the universe in grams and smaller than the radius of the electron in meters. Very dissimilar numbers often appear in the same calculation, and so scientists and engineers commonly use scientific notation as a way of keeping their integers down to a usable size and variety.

Here is the key point. The numbers we use cover a range from indefinitely near zero up to very, very large. There is another matching set, exactly the same but provided with a minus sign, on the other side of zero. See **Fig. 7.** Here I have written out several of

Original integer	Scientific notation	Metric prefix
.	.	
.	.	
etc.	.	
1,000,000	10^{6}	mega
100,000	10^{5}	
10,000	10^{4}	
3,000	3×10^{3}	
1,000	10^{3}	kilo
300	3×10^{2}	
270	2.7×10^{2}	
100	10^{2}	
30	3×10^{1}	
10	10^{1}	
1	10^{0}	
0.3	3×10^{-1}	
0.1	10^{-1}	
.03	3×10^{-2}	
.01	10^{-2}	
.003	3×10^{-3}	
.001	10^{-3}	milli
.0003	3×10^{-4}	
.001		
.0001	10^{-4}	
.000001	10^{-6}	micro
etc.	.	
.	.	
.	.	

Fig. 7. Practice writing numbers in scientific notation by making up new ones to go between those shown, and then venture off the ends of the scale. Where do metric prefixes giga and pico go?

these integers, namely some of those close to one (1). You can extend this list as far as you please towards zero, although you will never reach it, and as far as you wish towards infinity. You have no chance of reaching that either, since somebody can always write down a number smaller or larger than your best.

Yet however far you go you can always write your integer in the simpler form of Col. 2. Here I have rewritten it as a pair of significant digits with a ten-power supplement which tells you how far to move the decimal point, and which way, to reconstitute the original integer. The ten's exponent indicates the decimal must be moved to the right or if the exponent is negative you must put the decimal off to the left. Try writing down some numbers between those provided, and then some larger or smaller ones than any written here, and you will shortly develop a strong feel for this notation. You're getting it when you discover this sequence forms a kind of rainbow of numbers.

I've listed the familiar metric prefixes in the third column. Here you see the prefixes are made to order for use with the scientific notation system. Indeed, I think they fit in so well because that is where they came from. Note the engineer thinks in terms of numbers from one to one thousand, and you will too if you practice for a while.

Kicking Ten-Powers

Once we have a number rounded off and then converted into scientific notation form, we are nearly ready to calculate with it. But first we may want to make some changes, just for convenience, and there are two kinds of alteration we may find useful.

Both hinge on the nature of the ten-powers left over after we have sorted out the significant digits. You can trace these out in detail by imagining multiplications and divisions by tens, and you will soon master a shorthand-like skill for this simple work. The first question is, what do you do with a ten-power placed under a fraction bar?

Chances are you move it upstairs, since that is where your answer comes out. To make this change you simply cross out the ten-power under the bar and write it above the bar with its sign reversed. That is, if you have a 10^3 under the bar you replace it with a 10^{-3} upstairs. Here is an interesting thought: what if you had a 10^3 on *each side* of the fraction bar?

That would be as if we wrote down a 1000, and divided it by 1000. A one (1) must come of this. So we rewrite our $10^3/10^3$ as $10^3 \times 10^{-3}$, and the only way we can get a result of 10^0 or one is to *add* the exponents. Several examples are provided in **Fig. 8.**

$$10^3 = \frac{1}{10^{-3}}$$

$$\frac{10^3}{10^3} = 10^3 \text{ x } 10^{-3} = 10^0 = 1$$

$$\frac{10^7}{10^4} = 10^{7-4} = 10^3$$

BUT

$$\frac{10^7}{10^{-4}} = 10^{7+4} = 10^{11}$$

$$\frac{1}{860} = \frac{1}{0.86 \text{ x } 10^3} = \frac{1}{0.86} \text{ x } 10^{-3} = 1.2 \text{ x } 10^{-3}$$

$$\frac{30 \text{ mh}}{120\text{K } \Omega} = \frac{3 \text{ x } 10^{-2}}{1.2 \text{ x } 10^5} = \frac{3}{1.2} \text{ x } 10^{-7} = 2.5 \text{x} 10^{-7}$$

Fig. 8. Ten-powers can be moved around before and during the calculation to make the work easier.

And the other change you may want to make is, what if one of the significant digit numbers is an inconvenient size? For instance, perhaps you have come up with an 860 and you would like to have a 0.86 because you are dividing and you see that dividing by 0.86 will make the answer rather larger than the numerator of your fraction. You probably see already that you convert the 860 to 0.86×10^3, and put the 10^3 upstairs or maybe you place it next to a handy 10^{-3} and they cancel to reappear as a one (1). Very often in electronics work you would break up a 10^{-6} into a $10^{-3} \times 10^{-3}$, and take out one or both its factors in this way.

With some practice you can quite confidently kick ten-powers around inside the calculation you're going to do before you come to the actual computation with the significant digits. This makes the work very much easier, and errors far less likely. Well, let's put all these ideas to work in some real electronics-type calculations.

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Sample Real Calculations

We can begin with a very simple calculation that has a twist in it. I have a 1.2 megohm resistor and I think I should add a series 68 K resistor. What will be the result? Such a question could come up if we were doing bridge test on some resistors to choose a pair adding up accurately to some predetermined value. The twist is, to add these values using scientific notation. See **Fig. 9.**

1.2 megohms	$= 1.2 \times 10^6\ \Omega$	$1.2 \times 10^6\ \Omega$
plus		
68K ohms	$= 6.8 \times 10^4\ \Omega$	$.068 \times 10^6\ \Omega$
	Cannot add these!	$1.268 \times 10^6\ \Omega$

Fig. 9. When adding numbers in standard notation, change them all to the same ten-power suffix, and then add in the usual way.

When we add numbers in scientific notation, we must cast them all into the same form. Each must have the same ten-power multiplier. If we added a ten and a hundred but forgot to make this correction, we could wind up with a twenty or a two hundred, both quite in error. If we kick tens the hundred can be written as ten tens so that we wind up with a sum of eleven tens or 110, or we can do it in hundreds terms.

Now here is a familiar simple circuit. It is a simple rc circuit whose characteristics we see at a glance. At very low frequencies the capacitor has inappreciable effect upon the signal, and at very high frequencies the capacitor shunts the signal irresistibly to ground. At some intermediate frequency the capacitive reactance equals the resistance and the two components act as a voltage divider. This is the familiar minus-3-db corner frequency, and we want to calculate this frequency for the network shown. See **Fig. 10.**

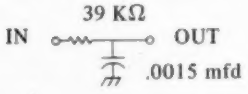
Perhaps we don't recall just what the equation is, so we write down something like it: resistance equals capacitive reactance. The f and the R change places, and we have the relation needed. Since there are so few numbers to plug in we bypass making a neat table and write the values directly into it. Besides, they are instantly available from the schematic.

If we call pi equal to three and double it, that doubles the rounding error but everything else too, so the percent error is the same. The resistance 39 K ohms becomes 4×10^4 ohms, and the .0015 mfd capacitor becomes 1.5×10^{-9} farads.

I didn't plan it that way but all this works out very easily to 36×10^{-5}, and then we kick exponents to discover a fraction practically the same as 3. The answer is 3 khz.

Now we can work this out in more detail to discover how our approximate answer lies in regard to all the possible answers. Yes, there are many possible answers because we did this one using nominal values for the components. In real life each has a tolerance of plus/minus 10% or more! Repeating these calculations in a more detailed and tedious way (I used my slide rule) brings the result our exact answer is very near 2.72 khz, and with real 10% components we should find a minus 3 db point between about 2.15 khz and 3.29 khz. Our approximate answer was safely within these limits.

Here is an example that demonstrates how easily we can work with numbers very different in value. How many electons could we place side by side across the diameter of



$$R = \frac{1}{2\pi fC}\ ;\ f = \frac{1}{2\pi RC}$$

$$f = \frac{1}{2\pi \times 39\ \mathrm{K}\Omega \times .0015\ \mathrm{mfd}} = \frac{1}{6 \times 4 \times 10^4 \times 1.5 \times 10^{-9}}$$

$$f = \frac{1}{36 \times 10^{-5}} = \frac{100}{36} \times 10^3 = 3\ \mathrm{khz}$$

Fig. 10. RC calculation becomes simpler with each step before doing multiplication and division. It becomes so simple there is almost nothing to do!

Sun diameter 1,390,600 km
Electron radius 2.81751×10^{-13} cm

$$\frac{\text{Sun dia.}}{\text{Electron dia.}} = \frac{1{,}390{,}600\ \text{km}}{5.62502 \times 10^{-13}\,\text{cm}} = \frac{1.4 \times 10^{9}\ \text{meters}}{.56 \times 10^{-14}\ \text{meters}} = 2.5 \times 10^{23}\ \text{electrons per sun diameter, approximately}$$

Fig. 11. This example shows that numbers of very different value can be as easy to handle as those not very different from another. We simply get an extremely large answer.

our sun? It must be very many. Looking up facts in a convenient handbook, I found the sun's diameter in kilometers and a nominal electron radius in centimeters. These values and the appropriate calculation appear in Fig. 11. Most of the work went into kicking tens around and although we may not be able to visualize 2.5×10^{23} electrons (I can picture 7 or 8, I think) we can work as easily with such a numerical value as we can with our old friend 47 ohms.

I haven't by any means exhausted the resources available for making calculations easier. But now you know a few of the basic ones, and you can look around for more. Practice helps wonderfully. There is one class of aids that deserves an article in itself which I have not mentioned yet. That is the various engineering aids available in a nearby book, a library, or an electronics supply house.

When you want to find a result, perhaps you can avoid calculations by looking it up. A handy engineering table may contain your problem all worked out. Or you may be able to use a graph, a nomograph (a sort of calculating graph) or a chart. Various slide rules and other calculators are available too, and all these tools can be used to make your work easier. Calculate if you must, yet always look for a better way to find your needed result.

Still, the key to using any of these aids is just the basic ideas I've set forth here. You can always use them. Good for you if you're using these tools already; this article will help you use them better. And if you haven't tried them yet, the concepts I've described will make mutual introductions much easier.

. . Jim Ashe

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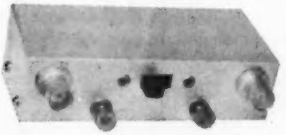

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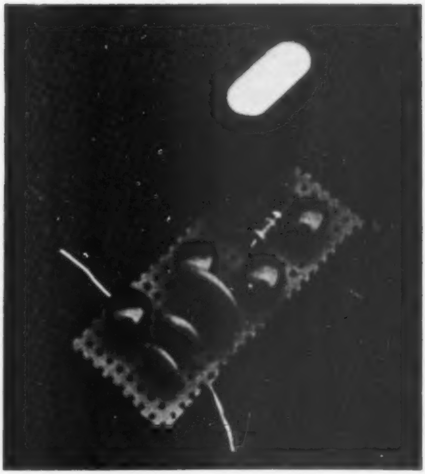
Universal Dual-Frequency Crystal Calibrator

John J. Schultz W2EEY
1829 Cornelia Street
Brooklyn NY 11227

Here is a simple and inexpensive crystal calibrator circuit using IC.s which can be used as presented or expended to build a "tailored" calibrator for any receiver.

It is often desirable to have a crystal calibrator with two or more output frequencies and with a rich harmonic content so that searching for markers on the higher frequency bands, such as 10 and 15 meters, is made easier. Both of these goals are easily achieved by the use of digital integrated circuits. Furthermore, the whole calibrator unit is far simpler to construct and more economical than ever would be possible with either vacuum tube circuitry or discrete solid-state circuitry.

The calibrator to be described, which provides markers at the fundamental crystal frequency used, is termed "universal" for several reasons. No tuned circuits are used and the unit can be used with almost any crystal from 100 kc to about 10 mc and still provide a fundamental and half-frequency output. The stages are really "building blocks" and the unit can be expanded in any manner desired to provide multiple frequency outputs or to use any division ratio that is an even multiple of two. Thus, depending upon the calibration markings on the frequency scale of a receiver or transceiver, one can build a calibrator that will suit these markings rather than accept the output of a standard calibrator circuit.



Many construction possibilities can be devised. Here the calibrator is assembled on a 1-inch x 2½-inch perforated board. The placement of the IC's simply follows Fig. 2 with the two oscillator circuit μL914's next to the crystal.

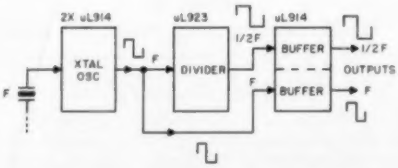


Fig. 1. Block diagram of stage functions in the calibrator.

Circuit Description

Fig.1 shows a block diagram of the basic calibrator unit. Two Fairchild μL 914 units form the oscillator circuit. As can be traced by following the circuit diagram of **Fig. 2** and the internal μL 914 circuit, the oscillator is actually a multivibrator which is controlled by the frequency of the crystal used. Circuit operation is very stable and the square-wave output not only has the desired richness in harmonics (remembering that a square wave is composed of a sine wave fundamental and an infinite number of odd harmonics of the fundamental), but is the required wave-form to operate the divider circuit.

The divider circuit uses a single Fairchild μL 923. The IC contains some 12 transistors in an arrangement known as JK flip-flop. It probably would only cause confusion to present the internal circuit of the unit, especially since its operation can be understood easily (for this application) simply in terms of its terminal functions. The unit can be regarded as a simple toggle switch that will only operate when it receives a positive going voltage (note that the voltage must be changing; a steady voltage does not affect it). So, if a square wave is applied which starts out positive, it will trip the switch. The switch will not be tripped again until the next square wave cycle. And again the switch will not be tripped until another whole input cycle occurs. Thus, the switch changes position half as fast as the input, and the output frequency is half that of the input frequency and also a square wave.

The buffer stage is not absolutely necessary but it does isolate the output from the divider stage and also insures a maximum voltage swing at the output. As shown in the insert diagram of **Fig.** 2 there are really two separate dual transistor stages in the μL 914, and each of them is used as a separate buffer section–one for the fundamental marker output and one for the half-frequency marker output.

One can include as many divide-by-two μL 923 stages between the oscillator and buffer as desired. Only the final divided output can be used or one can switch-select outputs at the input and output of each divider stage. Some of the tradeoffs that might be involved in constructing a long string of dividers to obtain a given marker frequency are discussed later.

Construction and Adjustment

Fig. 2 shows the wiring diagram of the dual frequency calibrator. There is little more to the unit than the interconnection of leads between the IC units. The photograph shows how this circuit was assembled on a piece of perforated board. The leads of the IC's were simply soldered directly together, although the use of IC sockets is recommended if one is not adept at soldering connections quickly, since excessive heat build-up can destroy the IC units. The circuit also easily lends itself to PC board construction.

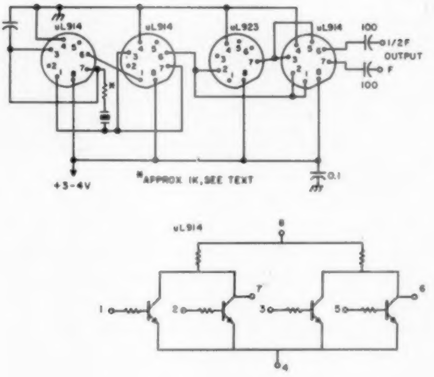


Fig. 2. Complete schematic of the dual frequency calibrator. Insert drawing shows internal circuit of the μL914. Terminal numbers for the IC's are shown as they would be seen viewing the units from the underside.

The 1K ohm resistor shown in series with the crystal may have to be varied in value somewhat to achieve immediate oscillation upon the application of power to the unit. A 5K potentiometer can initially be used in place of the resistor to determine the resistor value required and then a fixed value resistor substituted. An oscilloscope is useful but not absolutely necessary at this point to optimize the square wave output shape of the oscillator. The oscillator will work with crystals up to about 10 mhz and a crystal switch can be used if desired to obtain a choice of fundamental frequencies. Each crystal should, however, be placed in series with an individual resistor of 1K ohm nominal value.

The output is taken from each section of the μL914 buffer unit through 100 mmf coupling capacitors and may be connected to the antenna input circuit of a receiver through a selector switch. The output may also be connected to the secondary side of the input circuit of a receiver; but then the coupling capacitors should be reduced to a few mmf to prevent loading and detuning. One need use only as much capacitance as is necessary to obtain satisfactory signal output. With small amounts of coupling, satisfactory markers should be heard at least through 10 meters. Note should be made of the fact that when using both sections of the μL914 as buffers on different frequencies, some intercoupling does take place. The selected output will predominate, but the other output will also be heard. Normally, this condition has little practical drawback, but if it is desired to achieve maximum separation, only one section of a μL914 unit should be used per μL914 unit.

Normally, the slight adjustments necessary to choose the proper crystal circuit resistor and to couple the unit to a receiver are all that is necessary. No provision was made to "trim" the oscillator frequency for several reasons. When using low-frequency crystals (below about 500 khz), the accuracy will be sufficient for most normal uses. Also, normally this accuracy will be within that to which it is possible to adjust the crystal frequency by the usual audio zero-beat method. When zero-beating a marker with WWV, for example, the response of the audio system, headphones, etc., drops sharply below 50-100 cycles. So, there will be an uncertain area of about 100-200 cycles, anyway, using this method of adjustment where zero-beat seems to occur. However, in case it is desired to try to for more exact frequency output, a 15 mmf trimmer can be used either in parallel or in series with the crystal to alter its frequency.

The unit constructed used individual IC's which can now be obtained widely at moderate prices. If one builds a more elaborate unit the use of dual-IC's might prove cost saving.*

Expanded Circuits

As was mentioned before, as many μL923 divide-by-two units can be placed in series as desired. The output (terminal 7) of one μL923 unit goes to the input (terminal 2) of the next μL923 unit. Pin 4 of each unit is grounded and pin 8 goes to the supply voltage. In building a calibrator for a specific usage, however, it is worthwhile to explore the cost tradeoff between the μL923 units and the cost or availability of the crystal. Suppose, for instance, one desired to build a calibrator to provide markers every 20 khz to correspond to the frequency markings on a dial scale. **Fig.3** shows some of the combinations of crystal frequency and the number of μL 923 units that could be used. Normally, 40 or 80 khz crystals would not be feasible, but 160 khz crystals can be purchased for about $4. Also, many surplus low-frequency crystals are available at low prices which can be used. Many an odd-ball crystal frequency becomes very useful when one finds the right division ratio to use with it.

DIVISION RATIO	μL923 UNITS	XTAL FREQ (KHz)
2	1	40
4	2	80
8	3	160
16	4	320
32	5	640
64	6	1280

Fig. 3. Combinations possible to build a calibrator producing 20 kc markers.

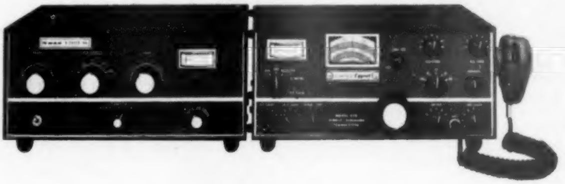
Summary

I have tried to present a simple IC calibrator scheme which one can expand, as desired, to cover almost any marker-frequency need. Simple circuits have been used, although only slightly more complicated ones are available to allow frequency division by any number–not just even multiples of two. But, they are not suggested as a first-time project, and it is desirable to have test equipment available to check their operation. The divide-by-two circuits are essentially fool-proof, unless one makes a wiring error.

Power for the calibrator can be obtained from a fairly well filtered source in a receiver or from two 1½-volt batteries in series. A simple zener regulator circuit is advisable if the operating power is obtained from the drop across a cathode resistor or from a rectifier across the filament line in a tube-type receiver.

. . . W2EEY/1

*Poly Paks, P.O. Box 942, So. Lynnfield, Massachusetts 01940, for instance, markets the 6M4 unit for $1.49 which contains two complete μL914 "chips" and the 10M4 for $1.69 which contains two complete μL923 "chips."



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If you do not have a knob of the proper description (they are a standard item, but not too common) turn the bit shank down to 1/4" and use a standard 1/4" knob or buy a set of bits with the shanks already turned down. My local supermarket sells a set of imported bits with turned down shanks for less than a dollar. While not of very high quality, they will work quite well in this application. Any knob you use should be the type with a metal insert. The all plastic types will not last.

William P. Turner, WA0ABI

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Versatilize Your Transceiver

If you are the type of fellow that likes to go down to the low frequency amateur bands (the dc bands) such as 75 and 40 meters and join in a round table or a net, then you probably felt distressed because you had to adjust your dial for every transmitter that was in the QSO. In most cases, being slightly off frequency is one of the evils that comes with having a transceiver with incremental tuning, because the thing is either misadjusted or else you forgot to zero the dern thing, or other innumerable reasons. Also the incremental tuning on my Eico 753 is so smooth due to the great bandspread that I wished to tune my transmit function with it as well. So, I put my thinking cap on and came up with a solution that makes it worthwhile to add this little tuning aid to rigs that do not have one.

The incremental tuning device is basically made up of a varactor diode biased by a pot on the front panel. As you vary the bias on this diode, its interelectrode capacitance varies, and this variable capacity is applied across the vfo tank to vary the frequency. On transmit the bias is derived from a tap on the pot in my 753, thus making this frequency independent of the setting of the incremental tuning.

To effect the change you will need a double pole triple throw switch, four coded and cabled wires about four feet long (four lead intercom cable is ideal) and a soldering iron. A minibox in which to mount the switch would also be nice.

Locate the receiver offset potentiometer and disconnect the wire going to the wiper arm and the one going to the tap. Now connect two of the wires in your cable to this wiper arm and tap. Splice the two remaining wires in the cable to the wires that came from the wiper arm and tap and remember the color codes.

The other end of the cable goes to the switch as shown in **Fig. 1b**. The two points marked X were the original connections. If you wired the switch according to the diagram, you should have:

Position 1 - Receiver offset only (label R).
Position 2 - Receiver and transmitter offset (label RT).
Position 3 - No offset (label OFF).

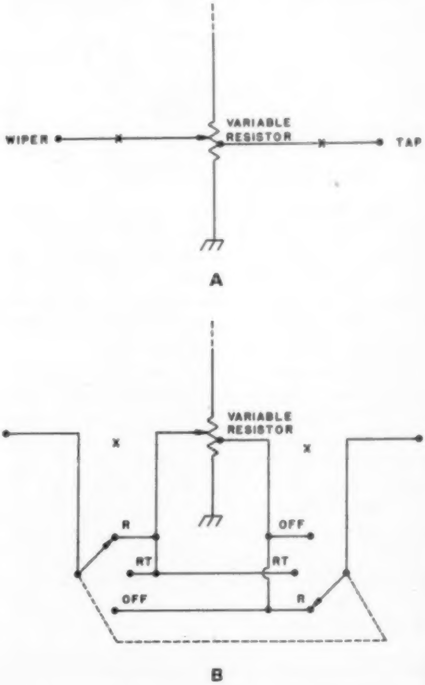

Fig. 1. 1a is the original circuit of the potentiometer that acts as the control. 1b is the same circuit with the switch added. Note that no permanent changes are made to the rig so as not to devaluate it, and it can be changed to the original condition in a couple of minutes.

The advantages of this conversion are as follows:

Position 1 is the same as you have now and there is no change in function. In position 2 or RT the frequency that you are receiving is the frequency at which the transmitter is tuned also. Use this position only to get a perfect zero beat or as a final touch up, never when searching for a quiet spot at the band edges. In position 2 you will also be able to correct for slight drift of the vfo and know that your transmitter is dead on your receiving frequency. In position 3 of your switch the offset feature is disabled, and whatever frequency you tune with your main dial will be both for transmit and receive. In this position if you are tuned in for receive properly, you know that you can't be blamed for being off frequency on transmit.

In case you like to operate in position 1, you can make a quick check by switching to OFF, tuning in a signal then switch to R (pos. 1). If the signal is off frequency now, loosen the offset knob, adjust the control for zero, beat on the signal, and tighten the knob with the hairline at exactly center or no offset. You should notice no difference in a received signal by switching between the OFF position and any other position when the offset control is adjusted correctly.

offset control is adjusted correctly.

After a little practice you will find that it is easy to monitor two frequencies slightly apart simply by adjusting your receiver to one with the main dial and to the other with the offset and then switching between OFF and R.

. . . VE3ECU/W0

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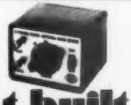

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It is now possible to obtain transistors which are capable of producing up to several watts of rf power at frequencies into the UHF region. Some transistors are capable of producing 30 or 40 watts of rf up to 30 mhz–at a price of course! Most transistors are within the average amateur's budget though.

The design procedure, especially for AM, is somewhat different to tubes but it is *not* difficult and once familiar with it you should be able to complete a design fairly quickly. Don't let all the equations scare you, not all of them are used in a specific design. The equations are no harder to use than Ohm's Law, so little or no trouble should be experienced.

In this article I will not cover SSB and transistor Class A linears. This is not because I don't like SSB (I do), it's just that I have not experimented with SSB and transistor Class A linears. Sorry about that.

The following design procedure will be for Class B, zero bias, rf power amplifiers for the following reasons: (a) ease of design (I'm lazy); (b) less components necessary (I'm a miser); (c) greater power gain than Class C; (d) no need to provide or develop a reverse base bias source.

The first decision to be made is whether you want to build a CW/FM or an AM transmitter. Having decided that, you now decide on what peak rf power output (carrier power for CW/FM or peak rf power out at 100% mod. for AM) you want at the desired frequency. Keep in mind that if you want more than 1 or 2 watts at VHF then you must be prepared to pay out quite a few dollars for the privilege. The same might apply at hf, though more power can be obtained relatively cheaply at HF.

The second decision you have to make is, "Which transistor will I use?" You should obtain the data characteristic sheets of several suitable transistors (ask the manufacturer). Now pick the transistor(s) which will supply the rf output at the desired frequency. Check that the minimum gain–bandwidth product, ft, is 2 to 4 times the desired frequency. If this leaves you with several transistors, choose one with the highest hfe (high frequency current gain), or the cheapest.

CW/FM Design Procedure

(1) V_{cc} is determined from the following formulae:

$$V_{cc} \leqslant \frac{BV_{CES}}{2} \text{ or } V_{cc} \leqslant \frac{\text{max. } V_{CEO}}{2}$$

Where BV_{CES} is the collector-emitter breakdown voltage and maximum, V_{CEO} is the maximum allowable collector to emitter voltage. V_{cc} is less than, or equal to half the maximum allowable collector voltage because the instantaneous collector voltage swings to twice V_{cc} on signal peaks.

(2) Now the optimum collector load resistance is given by:

$$R_c = \frac{V^2_{cc}}{2P_f}$$

where P_f is carrier power decided above.

(3) Now you have to match the collector load resistance R_c to the output load R_L (see **Fig. 1 (a) (b) and (c)**). The problem here is to take C_o (the transistor output capacitance) into consideration. At HF C_o will, with most transistors, not be terribly significant. It may become a problem though at VHF. Now **Figs. 1 (a), (b) and (c)** give circuits for the Pi, T, and

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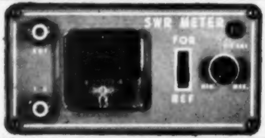

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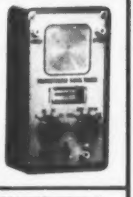

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parallel-tuned networks respectively. The Pi circuit is good where C_o is only very small or insignificant. Also the Pi network will feed through subharmonics of the output frequency, more so than the other networks. This may not be important. The T and parallel-tuned networks are very handy at VHF as C_o will not drastically affect them, note that they are easily adaptable to coaxial or trough-line configurations. For the design of these networks refer to the heading *matching networks*.

AM Design Procedure

(1) V_{cc} can be determined from the following formulae:

$$V_{cc} \leqslant \frac{BV_{CES}}{4} \text{ or } V_{cc} \leqslant \frac{\text{max. } V_{CEO}}{4}$$

V_{cc} is less than or equal to one quarter the maximum allowable collector-emitter voltage because the instantaneous collector voltage swings to four (4) times V_{cc} on modulation peaks. (100% mod.)

(2) Now the optimum collector load resistance (R_c) is given by:

$$R_c = \frac{3V^2_{cc}}{4P_f}$$

P_f = one quarter peak rf power at 100% modulation as decided previously.

(3) The matching network here is the same as for CW/FM procedure and the same remarks apply.

Matching Networks

The *Pi Network* configuration is shown in **Fig. 1 (a)**. The equations for determining the reactances of the components are as follows:

(1)
$$X_{C1} = \frac{R_c}{Q_L}\left(1 + \sqrt{\frac{R_L}{R_c}}\right)$$

where R_L is load resistance (ie. antenna), R_C is optimum collector load resistance, Q_L is loaded Q of circuit. Practical values are in the range of 5 to 12.

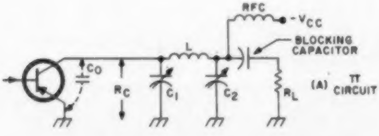

Fig. 1A. Circuit for the pi network configuration.

The capacitance of C_1 can be found from the nomograph on page 505 of the *Amateur Radio Handbook* by the R. S. G. B. or the *reactance chart* in chapter 2 of the *ARRL Handbook*.

(2) $X_L \cong X_{C1}$ 1. The inductance (L) can be found from the same handbooks mentioned above.

(3) $X_{C2} = X_{C1}\sqrt{R_L/R_C}$. The value of X_{C2} can also be calculated from the above mentioned handbooks.

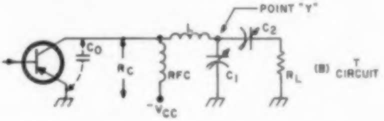

Fig. 1B. The T-network. In this circuit the loaded Q is increased by raising point Y above 1,000 ohms and transforming down to the load of impedance R_L.

The T–Network configuration is shown in **Fig. 1 (b)**. In this circuit the loaded Q is increased by raising point Y above 1,000 ohms and then transforming down to the load impedance R_L. The reactances of the components can be found by using the following equations:

(1) $R_Y = R_c\ (Q^2_L + 1)$

where Ry is the impedance at point Y, R_C is the collector load resistance, Q_L is the loaded Q. Practical values in the range 5 to 20.

(2) $$X_1 = \frac{R_y}{Q_L}$$

(3) $$Q_2 = \frac{\sqrt{R_y}}{R_c}$$

(4) $$X_2 = \frac{R_y}{Q_2}$$

(5) $$X_L = Q_2 \cdot R_c$$

(6) $$X_{C2} = \frac{R_L}{Q_L}$$

(7) $$X_{CL} = \frac{X_1 \times X_2}{X_1 + X_2}$$

The values of L, C_2 & C_1 can be found from the previously mentioned handbooks.

The *Parallel–tuned* network in **Fig. 1 (c)** is a parallel-tuned circuit with the load tapped up the coil. The transistor is capacity coupled to the circuit via C_2. The coil, L, transforms R_C to a higher

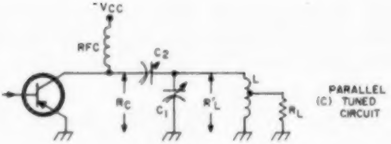

Fig. 1C. A parallel tuned circuit with the load tapped up the coil.

resistance R'_L. Now for practical circumstances the turns ratio is around 3 to 1 or 4 to 1. Thus: (a) $R'_L = 16\ R_L$ or (b) $R'_L = 9\ R_L$.

Above 100 mhz the equation in (b) should be used. Below 100 mhz the equation in (a) should be used.

The reactances of the components can be calculated from the following formulae:

(1) $X_{C1} = \frac{R'_L}{Q_L}$ Q_L in range 5 to 15

(2) $X_L = X_{C1}$

(3) $X_{C2} = R_C\left(\sqrt{\frac{R'_L}{R_C}}\right) - 1$

L_1, C_1 & C_2 can be found from the *ARRL* or *RSGB Handbook* as mentioned before.

Drivers

The driver has to deliver a certain amount of power to the base of the PA transistor, and this drive power (Pin) can be found on the manufacturer's data charts. A number of graphs will be given either showing rf power output (Pout) versus frequency for different values of Pin at a certain value of V_{CE} or a graph of Pout versus Pin for different values of collector voltages at a specific frequency. By referring to the appropriate graph the rf power needed to drive the PA (Pin) can be determined.

It will also be found necessary to match the driver to the PA base to achieve efficient power transfer. Keep in mind that these networks are not 100% efficient and allow for a reserve of power in the driver above that which is necessary to drive the PA.

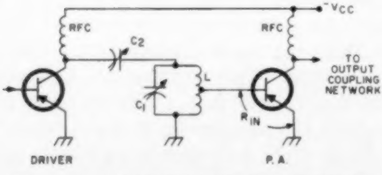

Fig. 2. R'_L is the resistance seen across the coil and R_{in} is the base spreading resistance.

By referring to **Figs.** 2 and 3 it can be seen that the matching networks are similar to that in **Fig.** 1 (c).

The equations for determining the components in **Fig.** 2 are as follows:

$$R'_L = 16\ R_{in} \quad \text{or} \quad R'_L = 9\ R_{in}$$

where R_L is the resistance seen across the coil. R_{in} is the base spreading resistance (rbb) or hie of the PA transistor. The same remarks apply here as before.

Now, (1) $X_{C1} = \frac{R'_L}{Q_L}$ (Q_L in range 5 to 15)

(2) $X_L = X_{C1}$

(3) $X_{C2} = R_{CD}\left(\sqrt{\frac{R'_L}{R_{CD}}}\right) - 1$

The equations for determining the components in **Fig.** 3 are as follows:

$$R'_L = 16\ R_{CD} \quad \text{or} \quad R'_L = 9\ R_{CD}$$

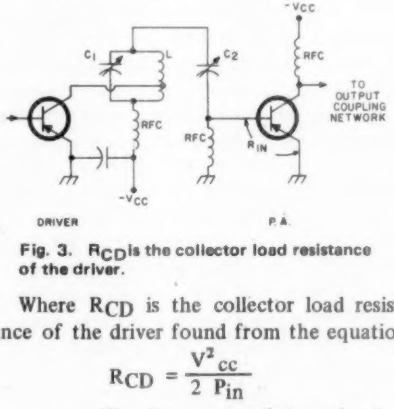

Fig. 3. R_{CD} is the collector load resistance of the driver.

Where R_{CD} is the collector load resistance of the driver found from the equation

$$R_{CD} = \frac{V^2_{cc}}{2\ P_{in}}$$

Pin from manufacturer's data sheet.

Now (1) $X_{C1} = \frac{R'_L}{Q_L}$ (Q_L in range 5 to 15)

(2) $X_L = X_{C1}$

(3) $X_{C2} = R_{in}\left(\sqrt{\frac{R'_L}{R_{in}}}\right) - 1$

Parallel and Push-Pull Operation

If you wish to achieve more power

output than one transistor will supply then parallel or push-pull operation could be employed.

Fig. 4 shows two transistors in a parallel configuration. The resistors in the emitters are to prevent one transistor "hogging" the current. The values of the resistors would be in the 1 to 20 ohms range depending on the power involved. Once initially adjusted so that the emitter currents of the transistors are equal, the circuit should okay. I would recommend that the T-network or parallel-tuned network be used in the output owing to a higher value of C_O. The same equations as given in the previous design procedures can also be used here. In choosing your transistor, don't forget that the power it should be capable of providing is a little greater than ½ P_f.

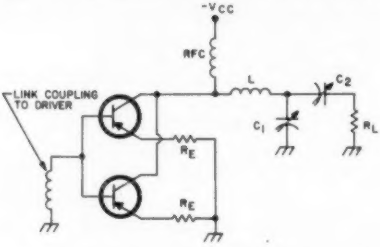

Fig. 4. Two transistors in a parallel configuration.

Fig. 5 shows two transistors in a push-pull arrangement. Note the similarity to tube circuits. L and C can be found by judicious use of a GDO and the link coupling to the drive should be adjusted for optimum output. Make sure that everything is quite symmetrical to ensure that both transistors receive equal drive.

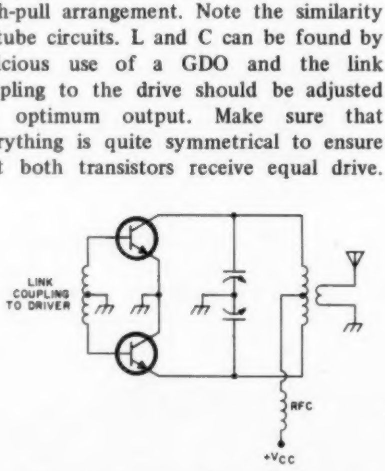

Fig. 5. Two transistors in push-pull arrangement. Make sure both transistors receive equal drive.

The remarks about design equations and power output given for **Fig. 4** above, apply here as well.

Class "C" Operation

Class C operation can be achieved by putting a low value resistor in the emitter or base connections as shown in **Fig. 6 (a)** and **6 (b)**. The drive required is greater than that for class B but the efficiency is somewhat greater. The value of the resistor and the drive power are best juggled in practice to achieve best efficiency and output. It appears to be a matter of individual adjustment for each type of transistor. Even different transistors of the same type in the same circuit require individual adjustment for optimum operation. Note that the emitter resistor is in the order of tens of ohms and the base bias resistor in the order of hundreds of ohms.

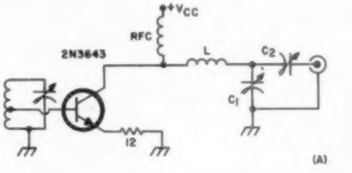

Fig. 6A. Class C operation by putting a low value resistor in the emitter connection.

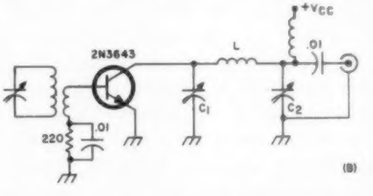

Fig. 6B. A low value resistor in the base connection for Class C operation.

Frequency Multipliers

Frequency multipliers are just another application of a Class C amplifier. The tuned circuit in the collector should be tuned to a frequency two or three times the frequency being injected at the base. I would suggest that a frequency multiplier should not be used as a final owing to the presence of subharmonics in the output.

When using a frequency multiplier as a driver, it should be no more than a tripler as it is difficult to get sufficient drive

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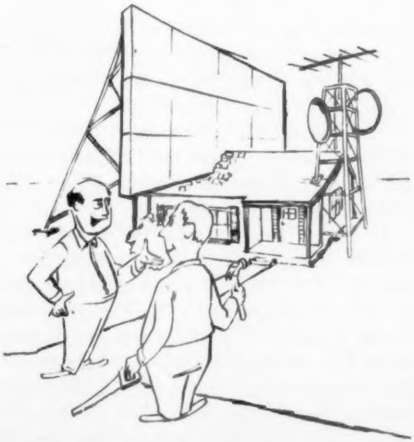
owing to lowered efficiency. When frequency multiplying, it is probably better and cheaper to use doublers throughout owing to greater efficiency and output.

Conclusion

Think over your next project—can you transistorize it? Don't just "lift" circuits—design them. It's not hard; don't let the equations fool you. Many of them are as simple as Ohm's Law equations. You don't have to own a slide rule or possess a Communications Engineering Diploma. Just sit down and carefully follow the procedure. Check your results, and there's your design. All you have then to do is build it. I hope it works for you.

. . . VK3ZRY



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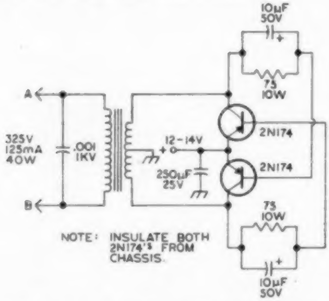
Two for Mobile

The purpose of this article is to present to the reader the choice of two mobile transistorized power supplies using filament transformers. Having examined a number of articles on the subject, and after hours of bench testing, I have found the circuits which follow offer these basic advantages low price, simplicity, and reliability. The two units described here were made up of materials at hand, and undoubtedly many variations could be used, particularly the transformers and the transistors.



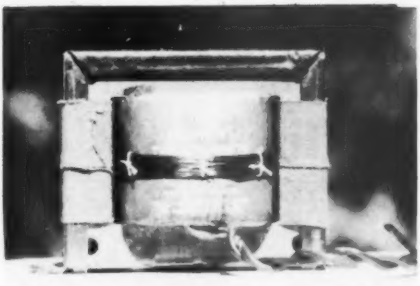
NOTE: INSULATE BOTH 2N174'S FROM CHASSIS.

Fig. 1. Mobile power supply schematic with an RC network establishing feedback. This unit is capable of 40 watts output, 525v at 125 ma.

The first unit is capable of better than 40 watts output, 325 volts at 125 Ma. It will be noted in **Fig. 1.** that feedback for oscillation is established by an RC network.

The second unit is capable of 90 watts output, 300 volts at 300 Ma. It will be noted in **Fig. 2.** that a feedback winding has been added to the transformer.

In selecting the transformer, be sure the window is large enough to accommodate the winding. The window is the inside opening of the core. In winding the feedback coil, cut four pieces of plastic tape three inches long, slip the tape (sticky side toward the core) between the core and the coil. Now pull the tape against the core. Do this on both sides. This will protect the enamel covering when you wind the feedback coil. Cut two pieces of No. 24 wire, 48 inches long.



Start feeding the wire through the window. Leave about 10 inches for a lead to the transistor base. Next wind five turns, using the second piece of wire. Continue the winding. The two center leads are scraped clear of insulation, twisted together and soldered. This will give you a ten-turn coil with a center tap. Use needle and thread and bind the feedback coil together in several places.

Note: Just tack the feedback leads to the bases of the transistors. These leads may have to be transposed when you first try the power supply. You can tell if it is oscillating by the audio note. If the note is not present, shut off power and transpose leads. In wiring the supply, use at least No. 10 wire from the fuse to the emitter. Use a fuse holder to make

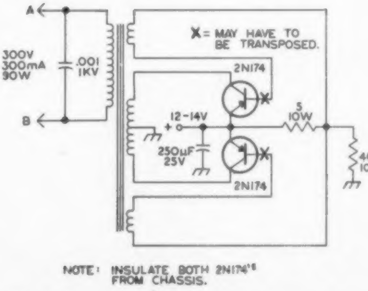


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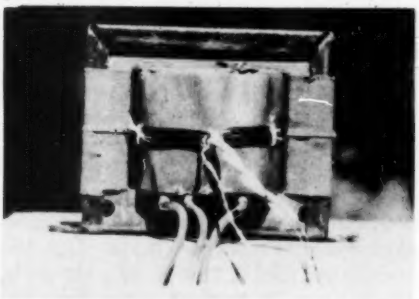
Fig. 2. Schematic of second mobile power supply, delivering 90 watts output, 300v at 300 ma.

positive contact (it is surprising how many do not). If holder heats up during use, replace with a better grade. The wire size from the battery to the relay, and from the relay to the fuse holder should be the largest you can use, and should not be smaller than No. 10. The relay contact should be capable of at least 50% more current handling capability than you would normally use. I prefer to use a double set of contacts wired in parallel.



The frequency of these units is determined by the inductance and capacitance of the transformer, as well as the bias. Naturally, the frequency is lower than a toroidal transformer, and it will be necessary to increase the value of the filter network to take care of the lower frequencies. It was not found necessary to use large heat sinks as such, just the chassis is used for this purpose. Be sure to use silicon grease on both sides of the transistor insulator and mount bias resistors away from the transistors.

The filament transformer used is a Triad F18X, 6.3 volts at 6 Amps. The filter capacitors were from a tv set, also the filter chokes. In the 90 watt unit, use two chokes in parallel. For the purist, use .001, 1kv capacitors and 475 K, ½ watt resistors for spike suppression and voltage equalization across each diode. See Fig. 3.

Both of these units were bench tested, using full power output, with a resistive load. The tests were conducted for a minimum of one hour.

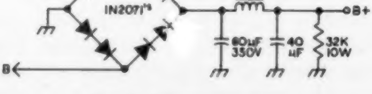


Fig. 3. Filtering method.

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In mounting the power supply, be sure to use the coolest spot possible. The space between the grill and the radiator is excellent. I long ago gave up using the driving compartment, not only due to heat, but the audio note produced after a few minutes becomes quite annoying.

In constructing either unit, use proper mechanical layout. Be sure to mount the bias resistors, bleeder resistor and transformer so that their heat does not add to the heat of the transistors. If you use a chassis for a heat sink, mount the transistors away from each other.

Although the efficiency of these units is not as high as totoidal units, from the standpoint of power input to power output, they do a good reliable job, and until toroidal transformers are readily available, and their cost is lowered, for the amateur who needs one or several mobile power units, these will give years of reliable service under normal conditions.

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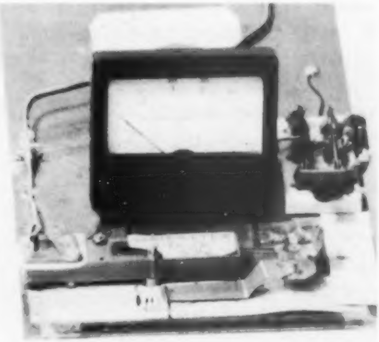

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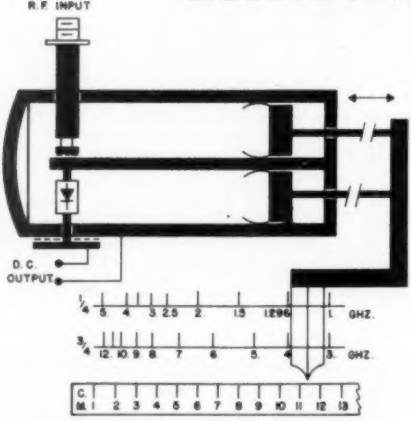

R.F. INPUT
D.C. OUTPUT
1/4
5 4 3 2.5 2 1.5 1.296 1 GHZ.
3/4
12 10 9 8 7 6 5 4 3 GHZ.
C.M. 1 2 3 4 5 6 7 8 9 10 11 12 13

Fig. 1. Coaxial cavity, basic circuit.

Wavemeters from 40 to 1400 mhz have been described in a previous article in *73 Magazine*. This one covers the range from 1,000 mhz up through 10,000 mhz. (1 to 10 ghz)

A quarter wave coaxial cavity is used up to about 5 ghz, and from there to over 10 ghz the three quarter mode is used. A complete explanation of these types of operation is given.

The same type of unit can be used as a very good tuned mixer from 1 to 10 ghz.

The Coaxial Cavity

The basic circuit of the coaxial cavity is shown in **Fig. 1**. A cylindrical outer cavity wall encloses a round rod some 4 inches long which is the center conductor—this center conductor is grounded at one end.

The Shape of the Cavity

The exterior shape of the cavity is shown in **Fig.2.** and is seen to be rectangular in cross section, with two thin walls and two thick side walls. Believe me, this configuration was not arrived at in one day! Designing tuners for X Band, I gaily started in with sections of thin-wall round pipe, the way I'd always done on uhf. The first thing you run up against is, how do you make the diode bypass capacitor? Machine out a curved saddle piece to fit exactly over the outer wall? Possible, but too expensive. And then how do you introduce the rf probe coupling into the cavity? Add on a "saddle" with a hole in it? These considerations and others, such as mounting (more saddles?) led to the

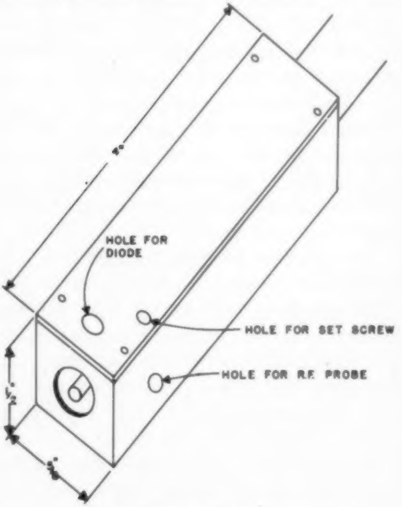


Fig. 2. Shape of the cavity.

abandonment of the pipe as a shape for microwave cavities; but not until a lot of time had been spent on the above mentioned items.

Diode holder and capacity

Looking at **Fig. 3.** you will see the first answer arrived at; but only after weeks and weeks of making different types and shapes. The center conductor is slightly flattened and drilled out to fit the diode prong. An 8/32 copper machine screw is drilled out to fit the other prong, then slotted with a fine jeweller's saw, and then compressed slightly to an inside diameter a shade less than the OD of the diode prong. In this way the copper screw will hold the diode as you insert it into the cavity. Believe me, that helps!

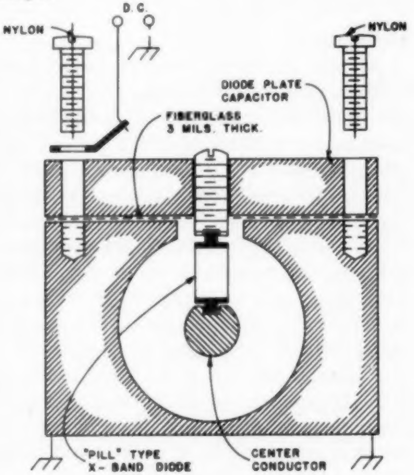


Fig. 3. Diode holder and capacitor.

The second answer is also evident from **Fig. 3.** as the diode bypass capacity can now be made efficient at X-Band. As mentioned before, you cannot "buy" a capacitor "good for X-Band. You can make it though, as shown in **Fig. 3.**, if the cavity body has been designed correctly for it. One of the thin wall sides of the cavity is drilled out (or machined out) just wide enough to clear the diode and it's holder, which is the 8/32 copper screw. The copper capacitor plate, which is thick enough to take at least a half dozen 2/56 threads, is drilled and tapped for the 8/32 screw, and clearance drilled in the corners for the 2/56 mounting screws. A soldering lug for the dc connection is used under one of these, and a three mil (three thousandth of an inch) thick sheet of fiberglass cut out to fit, larger than the plate. This helps to keep metal particles from lodging inside the tiny crack that might be there if the fiberglass sheet did not extend out beyond the plate all the way around. You can begin to see some of the detail needed at X-Band.

The rf probe, input and output connectors

Further reasons for the rectangular cross-section now show up in **Fig. 4.**, which details the rf probe connections. This item was also very troublesome in first models using pipe walls, where "more saddles" was the only solution. All "saddles" are eliminated by the rectangular shape. Small semi-rigid cable is used for the connector. I have some short lengths with X-Band antennas connected to them for use as "In-Space" pick-ups, feeding directly into the wavemeter cavity. There is at times an advantage in this type of "energy collection" (antennas) which will be taken up later.

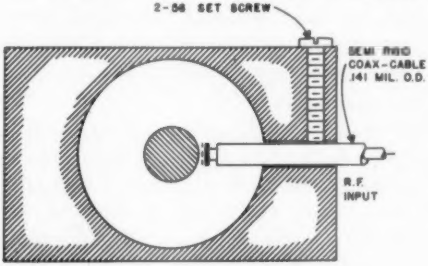


Fig. 4. RF probe connector detail.

Fig. 5. shows detail of the treatment of the cavity end of the rf cable, or probe. The outer conductor is cut away for about one quarter inch in length and removed. About a sixteenth or so of the Teflon is left, which is then removed from the center conductor. A

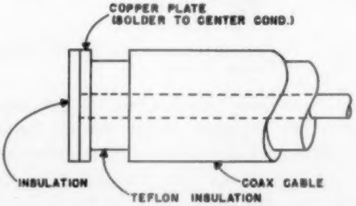


Fig. 5. RF probe detail.

thin copper washer (which I generally cut out of sheet copper since the hole to solder the center conductor is quite small) is then soldered to the center conductor, making the "capacity probe", as shown in **Fig. 5.**

Mylar tape or other good insulation is fastened to the side of this washer facing the center conductor. With this insulation in place you can push the probe all the way in, while testing, and still not have a dead short. Different thicknesses of fiberglass sheet can also be cemented on, to make up more permanent types of fixed capacitors, of different values.

For some uses, particularly in this one as a wavemeter, loose coupling is desired, but it must be securely locked with the set screw, otherwise your dial calibration and frequency reading will suffer.

Plunger fingers

Here is the most difficult item. It is hoped to have stock pieces made up for this work that you can purchase at reasonable cost. The fingers should be made of tempered beryllium-copper, which is not easy to work with.

Fig. 6. shows some details of the plunger and fingers. I assume, having been told so by "well-informed sources" (mechanical engineers) that these units should be made in a machine shop by competent machinists. Maybe so, as the ones I have made here in the shack by hand tend to lose their tension if not handled carefully.

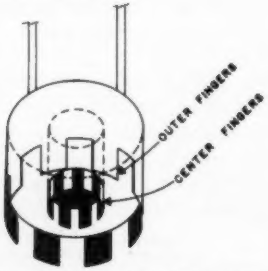


Fig. 6. Plunger details: A)End view, B)Outer fingers, C)Center fingers.

Fig. 7. shows the desired fit for these fingers. The plunger body should be an easily slide-fit *inside* the ¼ inch cavity, and the center hole in the plunger after the fingers should also be an easy fit *over* the center conductor.

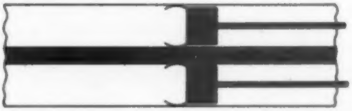


Fig. 7. Desired shape and curvature of the plunger fingers.

Two steel push rods lead back from the plunger through small holes in the back end of the cavity (see **Fig. 1.**); these terminate in the brass block which is furnished with a pointer for the frequency scale. Maximum extension of the plunger should be up against the end piece, as a positive reference point for the dial, in case of trouble after calibration. This point should be indicated on the scale as "minimum frequency" in order to reset the pointer if it should ever become displaced after calibration.

The diode

At present, the diode used is an X-Band "pill package," with a prong at each end as shown in **Fig. 3.** These are point-contact diodes, like the famous 1N23 ceramic cartridge types of World War II fame, only a lot smaller. Referring again to **Fig. 3.** always make sure that the ceramic part of the diode is, as nearly as possible, in the open space between the inner and outer conductors. This space is where the rf is! It is also important to make sure that there is as much metal surface continuity as possible along the cavity wall, across the fiberglass sheet X-Band capacitor insulation onto the diode capacitor plate, and from there over to the diode holder and onto the metal end of the diode.

The rf is at a maximum between the inner and outer conductors, which is an air space of a sixteenth of an inch. and that is where the diode should be.

The diode rf bypass capacitor, formed by the diode plate and the flat top of the cavity body, need only have a capacity which is relatively small; anything over about 20 pF is sufficient. What it *must* have is the proper *lack* of inductance! The details of how this act has been covered in previous paragraphs, and if you follow those details you will find little or no rf on the *outside* of the diode capacity plate or the dc lead from it.

X-Band is not just short waves. It is really short; like a quarter wave at X-Band equals 9/32 of an inch as you can plainly see, if you get one (or more) of those little plastic millimeter rulers in a stationery store for 5 or 10¢. Be sure and get some, by the way, if you're going to do anything above two meters.

Fig. 8. shows the millimeter scale, with s, C, and X-Band plainly showing.

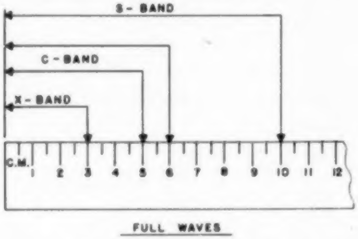


Fig. 8. Full waves for S, C and X-Bands on millimeter scale.

A handy wavelength-frequency chart is included here for your convenience, which is useful from the khz range way up *above* X-Band. See **Fig. 9**. Get to know the easy reciprocals, like 1 centimeter equals 30,000 mhz, 3 centimeters equals X-Band, 10 centimeters equals S-Band (3,000 mhz), 1,000 mhz equals 30 centimeters, etc. Very useful!

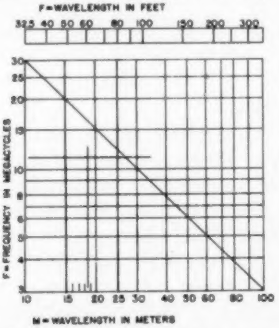


Fig. 9. Wave-length/frequency converter. Use of multiplying factors such as those at the bottom of the graph will cover any portion of the electromagnetic-wave spectrum.

The 3/4 mode and harmonics

Don't worry about that word "mode." Generally when something odd takes place in a cavity or waveguide, certain types of engineers tend to fall back on obscurantism (I seem to have fallen for that $64 word. It just means covering up). They say, "It jumped mode", or, "Spurious showed up."

Here's the straight dope. **Fig. 10** shows the quarter wave "mode" of operation. Starting at 1 ghz you will find *one* point of maximum dc output. If the oscillator under measurement is "running hard" with lots of 2nd and 3rd harmonic energy content, these will be found at 2 and 3 thousand megahertz, and possibly higher ones, which should drop steadily in power as you go up. The diode itself may cause some of these if hit too hard with the rf input.

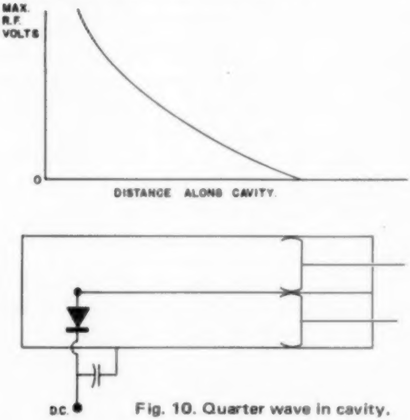


Fig. 10. Quarter wave in cavity.

Fig.11. shows the 3/4 wave mode, which is a very "natural" type of operation. Don't forget that in an instrument of this kind you are looking for standing waves and you want them to be of the greatest amplitude possible (within reason). So, if you tune the cavity by the plunger so that it measures

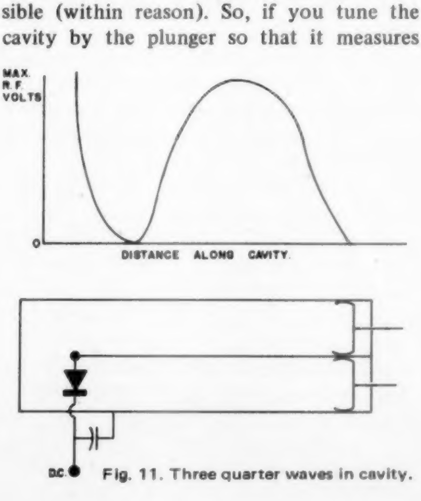


Fig. 11. Three quarter waves in cavity.

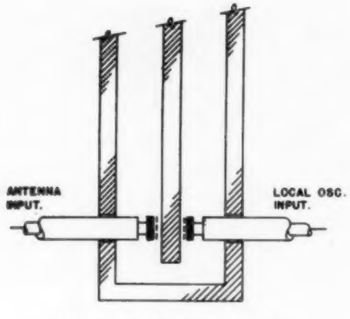


Fig. 12. Double input detail.

some three quarter waves on it (allowing for length-loading of the diode on the first quarter), you will find two peaks on the meter due to the situation shown in **Fig.11.** The higher the Q, and the lower the losses along the line, the more quarter waves can be found. For the 4 inch cavity shown, three quarter waves at S-Band are the longest that will fit.

A check on this operation is easy. Using the millimeter scale on the "dial', take several readings between maximums, for example, 22, 37, 51, and 67, add the spacings together, which comes to 45 millimeters, divide by three (the number of samples), and you will find an average of 15 millimeters for the waves which are standing on the center conductor (or "along the cavity", if you prefer) and there you are, 15 millimeters for the half wave, 3 centimeters for the full wave. Which is X-Band at 10,000 mhz or 10 ghz.

If you find numbers which are not well known, you can find the frequency on the chart, at least close enough to put you in one of the microwave amateur bands, such as 5,650 or 10,500 mhz.

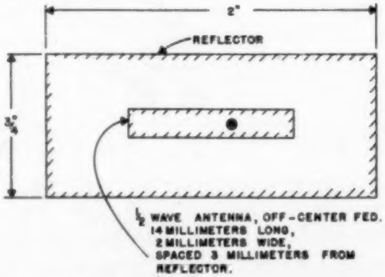

2"
REFLECTOR
3/4"
½ WAVE ANTENNA, OFF-CENTER FED.
14 MILLIMETERS LONG,
2 MILLIMETERS WIDE,
SPACED 3 MILLIMETERS FROM REFLECTOR.

Fig. 13. Test antenna–X-Band "two-element".

Use as a Microwave Mixer

This same type of cavity can be used from 1 to 10 ghz as a mixer for the front end of a superhet receiver covering those frequencies.

This application will only be touched on briefly here as the whole receiver is detailed in another article in *73 Magazine*.

Fig. 12. shows how to do it, so you can plan on this use, and make more than one, if you wish to.

Looking at **Fig. 12.**, you can see how useful it is to have *two* thick sides on the cavity, one for rf input and one for the local oscillator input.

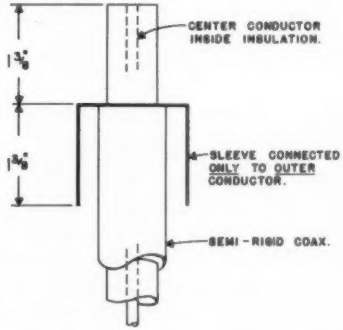

1⅜"
1⅜"
CENTER CONDUCTOR INSIDE INSULATION.
SLEEVE CONNECTED ONLY TO OUTER CONDUCTOR.
SEMI-RIGID COAX.

Fig. 14. Test antenna–S-Band. Dimensions suitable for amateur S-Band 2,400 mhz (omni-directional).

Conclusion

That about covers the details and some uses. The whole unit can be mounted on a piece of copper-clad, along with a 50 ma meter, the dial scale, and the centimeter-frequency chart. I broke down on this one and used a "regular" small microwave input connector for the rf. (Instead of an "RCA Phono Jack".) For connections to other units, such as oscillators and multipliers, small flexible cable may be used.

Fig. 10 shows a test antenna for X band, not the best in the world but good enough for a starter. With a lens in front it really picks up signals. **Fig. 11** shows an S band antenna for the 2,400 mhz amateur frequencies.

Hope to make arrangements to have this unit (cavity tuners) available for you.

. . . K1CLL

Audio Organizer

Bud Michaels WB2WYO
510 High Street
Victor, NY 14564

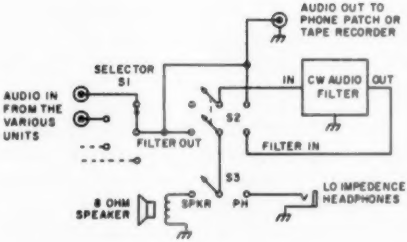
Examine any of the new lines of SSB transceivers. Chances are they require an external loud speaker. And on the less expensive ones, chances are also in favor of the need for an outboard audio filter for CW work. Add to the list of accessories, headphones, phone patches and tape recorder, and on top of this whole mess, more than one rig in the shack! You could have a nightmare switching all this stuff around.

With just a little organization and planning, you can turn all of this chaos into a neat, efficient audio control system flexible enough to fit just about any station situation.

This audio organizer lets you select any number of receivers or transceivers, couple your headphones in without having to fumble with the phone jack, switch your CW filter in and out as needed, plus providing auxiliary outputs for phone patch or tape recorder.

My organizer is built into the same cabinet which houses the speaker, but you can use any convenient box, as long as it is placed within easy reach for operation. All connections are made at the back of the box, so the operating area is kept free from exposed wires.

Selector switch S1 is a single-pole multiple contact switch, the number of positions depending on the number of different rigs you want to switch in. For most stations, a four-position switch should be more than adequate. The remaining switches can be either slide or toggle type. Connectors can be phone jack or phono type, either will work. You can see that this gadget lends itself to junkbox raiding on a grand scale.



Use a good grade loudspeaker, with 4 inches as a minimum size. A baffle made of wood is better than a metal cabinet, but if you do use a metal box, line it with fiberglass or audio damping material, or at least several layers of folded newspaper. This simple acoustic treatment will make the audio quality of your speaker system sound considerably better.

If you do intend to include a CW filter, there have been several articles writen in the past few years on effective, simple to construct units. Some of the more recent ones are: "Filter/ Monitor for the CW Man," Feb. 68 QST p.47; "Added CW Selectivity for Transceivers," Mar. 68 CQ p.32; "A Solid-State Audio Filter," Dec. 68 QST p.35.

....WB2WYO

Converting a CB Transceiver to Six Meters

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National City, California 92050

This article is a report on a recent project that was undertaken to determine the feasibility of converting a typical eleven-meter citizen's band transceiver to the six meter amateur band. The conversion was done on a Knight C-22 that was obtained in a trade with a local CB'er. The conversion involved considerably more effort than was expected, and is not recommended for the beginner. However, the results were very successful, and this was a very rewarding project.

The C.B. Rig

The transceiver as it was originally, had a transmitter with a single tube, a 6CX8. The triode section operated as an overtone crystal oscillator, driving the other section as a final straight through on 27 mhz. The audio section consisted of a 12AX7 driving a 12AQ5 which acted as both audio output amplifier on receive, and as a modulator on transmit. The receiver had two *if* stages on 1650 khz, both 6HR6's. The converter stage consisted of a 6EA8. The triode section served as local oscillator, and could be switched between either tunable or crystal controlled. The other section of the 6EA8 was the mixer. There was no *rf* amplifier stage in the receiver. A squelch and noise limiter were also included. Power was supplied by a self contained power supply that could be operated from either 115 VAC or 12 vdc.

Converting the Transmitter

The conversion was done in three major parts, the first of which is the transmitter conversion. This was done first because it seemed easiest. Just plug in a six meter crystal after changing the values in the tuned circuits, and it should work. It did work, but this path was eventually doomed to failure. Components and circuits that worked well at eleven meters were inadequate for vhf. Also, overtone crystals that would have to be used are expensive, and often difficult to find. It was finally decided to go to the configuration shown in **Fig. 1**. The old reliable 8 mhz crystal oscillator and tripler circuit was used with the triode section of the tube. The other section was used as a doubler and final amplifier stage. When this circuit was first constructed with the 6CX8, the drive to the final was inadequate for acceptable modulation, and the tube was changed to a 6BA8A. This

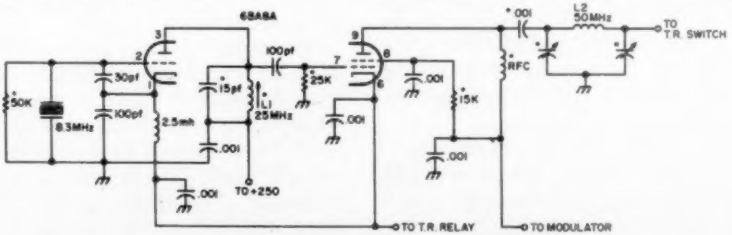


Fig. 1. Transmitter circuit.

tube provided the slight increase in drive that was needed, and good results were finally obtained.

All the original bias resistors were retained, and it is assumed that they are of proper value. The tank coil was rewound with five turns of number 18 wire, ½.. in diameter. The plate blocking capacitor and the *rf* choke as well as the pi net capacitors were left as they were originally, and they work well. Both sections of the tube were connected to the B+, and the cathodes were grounded by a relay to transmit.

The power input to the final stage is about five watts, and the output is about one watt. This is typical performance when a tube is operated as a multiplier stage. More output could have been obtained if another stage were included in the transmitter, but the effort required and the lack of space more than offset the small increase in output that could be obtained.

On the first tests with a short length of solder for an antenna, solid contact was obtained with a mobile station about a mile away. It was decided that a better antenna was needed, and the rig was connected to the 40 meter dipole. This quickly brought a visit from a neighbor, with a TVI complaint. Perhaps it was just the antenna, but one of the characteristics of this type of transmitter is its high TVI to power input ratio. Since this transceiver was intended for a mobile installation, TVI was not considered a serious problem, but if it is to be used as a fixed station near television receivers, precautions should be taken to prevent interference.

The rf Amplifier

The methods used at 27 mhz are often unsatisfactory for vhf work, and to provide added sensitivity and selectivity, an *rf* amplifier must be added to the receiver. An MPF-102 was chosen because of its low cost, simple circuit, and good performance. Power was obtained from the cathode of the 12AQ5 audio output tube, and about 15 volts was obtained. The circuit of Fig. 2 was used. The grounded gate configuration was used in order to avoid the necessity of neutralization. The two diodes, D1 and D2, were placed in the input to protect the transistor if the receiver is near a strong 50 mhz *rf* field that could cause damage. The diodes are of the high speed switching variety, and were obtained from a friend. He argued that the 1N34A diodes used in the Handbook[1] are inadequate for protection of transistorized receivers.

In spite of all these careful precautions, the FET was soldered into the circuit, backwards. No amplification resulted, and the error was discovered. No damage seems to have been done, however, because the stage worked quite well after this error was discovered and corrected.

The MPF-102 works well with any voltage between 9 and 15 volts, and has shown no tendency toward instability. Considering its small size, low cost, good performance and low power consumption, the MPF-102 was a good choice for this application.

The Converter Stage

Here, in the converter, the greatest problem was encountered. At first, the tunable oscillator was padded down to about 24 mhz so the second harmonic could be used for local oscillator injection to the mixer. This worked, but resulted in very poor conversion efficiency, and is not recommended. This was discovered when the grid dip oscillator was left on the table near the receiver.

The GDO sitting a foot away put out a

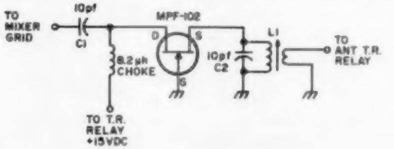


Fig. 2. *RF* amplifier.

L1–9 turns on ¼" diameter iron-slug form with 2 turn link. C1, C2–disc ceramic.

better local oscillator signal than the one in the receiver!

After a great deal of experimentation, the circuit of **Fig. 3** evolved. The oscillator circuit is similar to the Handbook$_2$ circuit that was used with an FET. A considerable amount of trouble was experienced with this circuit, and it was finally discovered that the long and sloppy leads used in the CB rig were inadequate for vhf. After the wiring was cleaned up, the oscillator was giving reliable service.

The bottom half of the original oscillator coil was used. The can which shields the oscillator coil should be removed to check terminal connections. This coil consists of seven turns on a ¼" diameter slug tuned form. Actually, a few more turns should be added because this circuit is just barely on frequency with the slug all the way in and all capacitors at maximum capacitance. The component values given may not be optimum, but will work if careful attention is paid to the wiring and layout. NPO disc ceramic or mica capacitors should be used in the tuned circuit to prevent thermally caused frequency drift.

The mixer half of the 6EA8 also gave some trouble. At first, the mixer was oscillating, and the trouble was thought to be the fault of the *rf* amplifier stage. The trouble was traced to an un-bypassed cathode in the mixer, and some other problems were discovered. The screen and cathode resistors were too high in value to allow optimum mixer performance, and had to be changed to the values shown in **Fig. 3**.

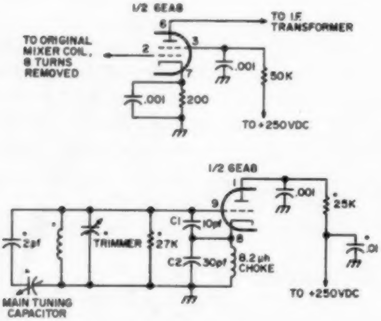


Fig. 3. Converter.

*Indicates original component.
Resistors ½ watt carbon.
C1–NPO or mica.
C2–NPO or mica.
Other fixed capacitors are disc ceramic.

After these problems were corrected, the front end of the receiver was tuned up and found to be operating very well.

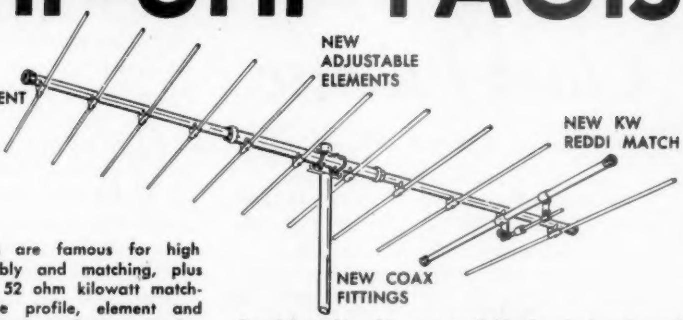
Switching Considerations

The relay in the transceiver had two double throw contacts and one single throw contact, normally closed. One double throw section switched the B+ for certain parts of the audio stages, and the other double throw contacts ground the transmitter cathodes on transmit, and ground the speaker terminal, connecting the speaker, during reception. The third single throw contact was used to disconnect the receiver from the antenna during receiving. The transmitter was originally permanently connected to the antenna.

This arrangement was considered unsatisfactory, and the following modifications were made. The single throw contact was used to control the voltage to the FET *rf* amplifier. The double throw contacts that switched the speaker and transmitter were used as an antenna change-over switch. Now the transmitter tank circuit is completely disconnected during transmit. Interconnections were made with Amphenol 21-597 Subminax 75 ohm coaxial cable that was in the junk box. RG-174 could also be used, and is a little smaller. Another relay was added to perform the function that was not handled by the original relay. The relay used was obtained from surplus, and was the sensitive type with an 8000 ohm coil. A 50 K ohm resistor was placed in series with the coil, and connected to the 250 volt B+. The other end of the relay was switched to ground by the microphone push to talk switch as was done with the original relay. The relay was mounted under the chassis, and takes up very little room. Also, the power consumption is small.

Final Results

The results from this project showed that a CB to six meter conversion is practical, but more difficult than was expected. If a CB transceiver is available, and there is a desire for a compact six meter transceiver for mobile or portable use, this is an excellent project. The inherent qualities of the CB transceiver with its squelch and noise limiter make it ex-



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cellent for mobile use. The transmitter, though low powered, is easy to build, has good audio quality, and provides good short range communication. A comparison with a similar commercial transceiver[3] under mobile conditions showed similar performance on transmitting, and decidedly superior performance receiving. The transceiver, with its small size and built-in power supply is easy to mount, even in a compact car.

The complete conversion took four days of afternoons and evenings, and cost less than five dollars. The more experienced builder could probably do it in a weekend, especially with the help of this article.

So, considering the successful results of this conversion, the technician or vhf enthusiast with a "useless" eleven meter transceiver on his hands should be encouraged to know that a successful conversion is possible, and practical.

...WB6BIH

References

1. Headquarters Staff of the American Radio Relay League, *The Radio Amateur's Handbook*, Newington, Conn. 1968.
2. *The Radio Amateur's Handbook*, page 392.
3. The WRL "Tech-Ceiver 6" TC-6A.

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Getting Your Extra Class License

Part XI – Oscillators

Some 50 years ago, a revolution hit amateur radio. Up to that time, the spark gap had been king–but about the time hams returned to the air after WWI, a different sound began replacing the roar of King Spark. The continuous-wave oscillator had become available, and its much narrower bandwidth permitted dozens of operators to work in the space required by a single spark transmitter.

It was much the same story as the battles when SSB came onto the scene one and a half wars later, but the revolution toppled King Spark from his throne and today the spark-gap transmitter is illegal. All amateur radio communication makes use of the CW oscillator in some fashion, either as a CW source in itself, as the source of a carrier to be modulated, or as the source of a carrier to be suppressed after sidebands are generated for transmission.

Because the CW oscillator is so fundamental to modern radio communications, the FCC insists that would-be Extra Class operators have an adequate knowledge of oscillator operation and adjustment. In this month's installment, we'll cover five of the Extra Class study list questions which deal directly with oscillators–and also quite a bit about oscillator operation which doesn't appear directly in the study list but which is essential to other questions which do.

The specific study list questions with which we're dealing this time are (numbers, as always, are those assigned by the FCC):

17. How does the positioning of a powdered iron tuning slug affect the frequency of the oscillator it is tuning?
28. What frequency should a crystal oscillator circuit be tuned to for maximum stability?
29. What determines the fundamental operating range of a multivibrator?
31. What factors determine the frequency at which a quartz crystal will oscillate? List some of the advantages of using crystals in amateur equipment.
36. How can the safe power input to a crystal oscillator circuit be determined?

We'll follow our usual custom of re-phasing these five questions from the study list into other, more general, questions, and then examining our broader questions as well as to any similar ones which may appear on the actual examination.

To start, we must examine oscillator principles in detail. The major question involved in this study, which will be our first broad query, is "What Keeps An Oscillator Going?" Of course, we must also determine what gets it started in the first place, but the important thing about an oscillator is that it *does* keep going, and that's where the details are to be found.

With a base of oscillator theory on which to build, we can then turn our attention to more specific oscillator questions. Most of the FCC questions deal with the use of crystals in oscillators, so let's make our second question simply "Why Use Crystals?" and in the course of getting some answers to this we should wrap up FCC question 31 rather thoroughly. Then we can continue by asking "What Limits The Use of a Crystal Oscillator?" and take care of questions such as numbers 28 and 31.

Not all oscillators use crystals, nor do all of them even produce sine-wave outputs, and we need to look at these lesser-used types as well. To do so, we'll ask "Can The Inductors Be Left Out?", and the answers should take us through not only several types of multivibrators but even some coilless sine-wave oscillator circuits for both rf and af.

Most discussions of oscillators and oscillator theory fall into one of two broad groupings–either they are overly simplified and so fail to mention many everyday problems to which oscillators are subject (in efforts to avoid any math at all), or they are overly precise and require a knowledge of engineering math (particularly the area of Laplace transforms, poles, and zeroes) to be comprehended. We'll try to steer a middle course. We won't be able to avoid all the math, but we should be able to keep things at least as simple as Ohm's Law. This may lead us into some oversimplifications here and there, but if we can't keep them minor we'll try to flag them out to you so that you will know where any potential trouble spots may lie. Fair enough? Let's get on with the questions.

What Keeps an Oscillator Going? An "oscillator," in its most general sense, is a circuit which produces from dc-only inputs an output which contains an ac component. The output of the oscillator may be ac, or it may be pulsating dc, but in either case it contains an ac component which was not present in any of the input voltages or currents. The purpose of the oscillator is to produce this ac component.

In most oscillator circuits we use in ham radio, the ac output is a sine wave or very nearly one, but this isn't necessarily true of all oscillators.

The frequency of the oscillator's output may be anything from subsonic (below 10 hz) audio frequencies to rf in the EHF range; a laser, in fact, is an oscillator which has an output frequency in the visible light region.

But the oscillators we're most interested in right now are those which produce sine-wave rf output in the region from say 250 khz up through 30 mhz; these all work in about the same basic way. All conventional oscillators in this applications area based upon feedback principles; in the UHF region especially, some non-feedback oscillators are used.

Any feedback oscillator can be separated into two main sections for analysis. When this is done, the differences between the many types of oscillator circuits–and the basic similarities of all of them–become more evident. We've done so in **Fig. 1**.

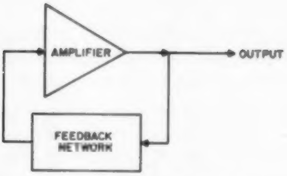

Fig. 1. Basic components of any electronic oscillator are shown here. Amplifier is heart of the circuit, while feedback network takes a part of the amplifier's output back to provide input and thus permit oscillation to continue. If feedback factor times amplifier gain is equal to or greater than 1, circuit can oscillate. Differences among oscillators come about by the many different types of amplifiers which can be used, and the many ways of arranging the feedback network.

The two main sections of any oscillator, as in **Fig.1** shows, are the *amplifier* and the *feedback network*. The amplifier part, in itself, is usually a completely conventional amplifier for the frequency range at which the oscillator is to be used. In fact, almost any amplifier can be turned into an oscillator by providing a suitable feedback network–and this feedback network often gets provided by accident, giving us an unwanted self-driving amplifier. Such a situation is known as "spurious oscillation," and is often the subject of much grief. "Parasitics" are another instance of this same principle at work.

We'll get into undesired oscillations and what to do about them in a future installment; this time around we're sticking to desired oscillations.

The feedback network suitable for any particular amplifier circuit in order to turn it into an oscillator depends to a great extent on the amplifier circuit itself. What the feedback network must do is to feed back to the input of the amplifier just enough of the output to provide adequate drive, and do so in the proper phase.

Most conventional amplifier circuits reverse the phase of the signal between grid and plate circuits, and a phase-reversed signal tends to cancel itself out. For such circuits, the feedback network must introduce another phase reversal so that the fed-back signal is in the proper phase to produce the same output signal.

In addition, most conventional amplifier circuits have some gain between input and output; the feedback network must have corresponding loss, so that just enough signal is fed back to keep things going. Too much feedback will at the minimum produce distortion of the output signal; it may go so far as to prevent steady oscillation.

An oscillator is usually intended to produce an output signal of some single specified frequency. This requires that somewhere in the oscillator there be a tuning circuit to select that frequency and reject all others.

Normally, this tuning circuit is made a part of the feedback network, because most tuning circuits also automatically provide phase-shifting. The phase reversal necessary in the feedback and the frequency selection necessary to restrict output to a single frequency can thus be combined into a single set of elements.

At this stage, we have established the minimum requirements for an oscillator–but we haven't even looked at our main question, "What keeps it going?" Let's start that study by assuming that it is, in fact, already going (then we can find out how it gets started later).

Just to make things definite for our first example, let's select some figures out of the air. Let's assume that our amplifier has an exact 180 degree phase reversal between input and output, and a voltage gain of 10 times. That is, one volt peak-to-peak rf input will produce 10 volts peak-to-peak output in reversed phase.

We won't specify the feedback network right now. Instead, we'll try several different sets of characteristics for the feedback.

With no feedback network in the circuit, we have simply an amplifier. When the input is removed, the output disappears also.

Let's try a feedback network which feeds back 1/100 of its own input (which is the amplifier's output), and leaves phase unchanged. Now our 1-volt input will produce 10 volts output, but 1/100 of this 10-volt output, or 1/10 volt, will be put back into the input. Its phase is reversed from the original input, so it cancels out 1/10 volt of input and leaves 9/10 volt available for the amplifier. This, in turn, cuts the output down to 9 volts–and so reduces the feedback voltage to 9/100 of a volt. This action increases the available amplifier input voltage from 0.9 volt to 0.91 volt. The round-robin action finally settles down when the output becomes 9.1919191919 . . . volts, because when 1/100 of this is fed back the input available for the amplifier is 0.9191919191... volts. The amplifier itself still has a gain of 10, but the effect of the feedback network was to reduce the effective gain to 9.1919.

If we put in a feedback network which feeds back 1/10 of its own input, in the same phase, then a 1-volt input signal will produce 10 volts out (originally) and 1 volt in reverse phase from the feedback which cancels out the original input. With the input gone, there is no output to feed back. The resulting round-robin action finally settles down when amplifier output is 5 volts. Feedback then is 0.5 volts, which cancels out half the original input and lets the remaining half be amplified ten times to produce the 5-volt output.

If all of the output is fed back (a feedback factor of 100%) without phase change, the effective amplifier gain will be reduced to something less than 1. In our example, the gain will drop to 10/11. A 1-volt input signal will then produce 10/11 volt output. This will be fed back to cancel most of the input; only 1/11 volt of input will not be cancelled. The amplifier will boost this by ten times, providing the 10/11 volt output.

All of these examples so far left the phase of the feedback voltage unchanged, which with our specified amplifier meant that the feedback voltage was out of phase with the input. Such feedback is known as negative feedback, and is used to improve amplifier action (as examined in some detail in our Advanced Class study course).

If we use a different feedback network and change the phase of the feedback voltage so that it is IN phase with the original input, things come out differently.

Feeding back 1/100 of the output as we did in our first example, but with phase reversal included in the feedback network, we find that a 1-volt input gives us a 10-volt output, which produces 1/10 volt of feedback. This increases our effective input to 1.1 volts, giving us 11 volts output and increasing the feedback to 0.11 volt. The effective input rises a little more, to 1.11 volts; the feedback rises with it to 0.111 volt. Each pass around the feedback loop brings the effective input voltage up just a little bit more–but even an infinite number of passes can never bring the output any higher than 1.111112 volts, because each pass merely adds 1/10 of the previous input. The effective gain of this arrangement levels out, then, at 11.111111111..... times.

Let's see what happens if we bring the feedback percentage from 1 up to 9%. A 1-volt input gives us 10 volts out the first time, and we feed back 9/100 of this to bring the input up to an effective 1.9 volts. Output rises to 19 volts. Feedback rises to 1.71 volts, which adds to the previous 1-volt input to give an effective input of 2.71 volts and an output of 27.1 volts. Feedback comes up to 2.439 volts, and output consequently climbs to 34.39 volts.

It might appear that output in this case would climb forever, but it doesn't. When the output has climbed to 100 volts exactly, the resulting feedback voltage is 9/100 of that or 9 volts. Added to the original 1-volt input, this gives 10 volts effective input, and the amplifier's original gain of 10 boosts this to the 100 volt output level.

What happens if we make the feedback percentage 10% now? Let's assume that the amplifier was producing a 10-volt output signal with no feedback, and we suddenly connect a 10-percent feedback network to it. The feedback voltage becomes 1/10 of 10, or 1 volt. If the 1-volt input signal is still present, this will give us 2 volts effective input and a 20-volt output. The next pass around the feedback loop will have 2 volts feedback and 1 of input for 3 volts in and 30 volts out; the next after that will bring us up to 40 volts out, and so forth. The rise in output will never stop because of running out of feedback; the only limit is that imposed by the available power-supply voltage swings. And if we remove the 1-volt input signal at any time after the feedback loop is connected, what happens? If we're getting 20 volts out then instead of rising to 30 volts next time around the loop the output would remain steady at 20 volts, because the 2 volts fed back would provide a 2-volt input signal.

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If we had been getting the 10 volts out when the input signal was removed, then we would hold steady at 10 volts output, because 1 volt would be fed back and this would keep output constant.

In fact, no matter *what* output we were getting when the input signal disappeared, we would hold steady at that level, because the feedback factor is just right to give the amplifier an artificial input signal developed from its own output signal. We now have an oscillator.

Notice that this happened with a feedback factor of 10% and an amplifier gain of 10 times. Had the amplifier gain been 100, a feedback factor of 1% would have been enough to do the job. What is required is enough feedback so that the feedback fraction times the amplifier gain is equal to 1. If the signal fed back is in phase with the input signal, and feedback fraction times gain equals 1, the circuit will oscillate.

In practice, of course, the gain of the amplifier may vary as tubes or transistors age, resistors change value, and power supply voltages change with load. Any time the product of feedback fraction times gain drops below 1, the oscillator cannot keep going. However, the product can be greater than 1, and most oscillator designs make it slightly greater just to give a safety factor.

If the feedback is greater than the minimum required for oscillation, output will not be steady at some accidental level. Instead, it will climb to the point at which available power-supply voltage or some other factor limits it, and level off there. For this reason, the amplifier portions of most rf oscillators operate in Class C, with current flowing only during parts of the cycle.

This fact, in itself, introduces some new problems into the action of keeping the oscillator going. When the amplifier works only a part of the time, as is always true in Class C operation, then something must provide a "flywheel" effect to carry the circuit through those portions of the cycle in which the amplifier is effectively "dead." The same resonant circuit used for tuning the oscillator usually provides the "flywheel" by storing energy in its fields and releasing it a fraction of a cycle later.

The resonant circuit is not necessary, though, so long as *some* energy storage capability is included. The multivibrator, for instance, stores its "flywheel" energy in the coupling capacitors. A crystal oscillator uses the crystal itself for energy storage, by converting electrical energy into mechanical energy and back again. We'll get into these a little later, however. To keep things relatively simple at this stage, let's concentrate on the types of oscillators which store their energy in resonant circuits.

In previous installments of this study course we have examined the idea of "Q," the "quality factor" of any energy-storage element, at some length. Since an oscillator operating in the Class C condition requires some type of energy storage within its circuit in order to keep going, we might guess that the Q of that energy storage (in the present case, of the oscillator's resonant circuit) is of some interest to us. And that quess would be correct.

One of the ways in which Q is defined is as the ratio of energy stored per cycle to energy dissipated per cycle. This definition tells us that a circuit with a Q of 1 must dissipate all the energy it stores; such a low Q is usually avoided, and that's why. A storage device which dissipates everything you attempt to store in it doesn't do much towards keeping the energy around for future use.

Any energy taken out of the resonant circuit for any reason is lost so far as the circuit is concerned, and in the definition of Q just quoted, the energy deliberately taken out is included in the energy "dissipated." Thus the Q of a working circuit is affected by the degree to which the circuit is loaded; the heavier the loading the more energy is taken out per cycle, and the lower will be the Q.

The resonant circuit of an oscillator must have reasonable high Q in order for the oscillator to operate; this requirement comes directly from the fact that the resonant circuit is storing the energy to provide a flywheel effect, and the circuit Q serves the same purpose as does the high mass of a mechanical flywheel.

If circuit Q is too low, the circuit may fail to oscillate despite all connections being correct; this is frequently a rather perplexing problem to a homebrew artist who has modified a "borrowed" design to operate at some new frequency range, and tuned the circuit to resonance by using a dipper without considering the Q which may be required to keep things going.

Q may be increased in either of two ways. The circuit may be less heavily loaded, so that less power is taken out, or the capacitance of the circuit may be increased (and its inductance decreased to match, to maintain the proper frequency). Increasing the capacitance is preferable.

Should this fail to solve the problem, it may be that the circuit is simply not providing enough drive to its amplifier portion. In this case, the remedy is to increase drive by increasing the amount of feedback. The technique for increasing feedback will vary with the particular circuit; in general, the idea is to couple more of the output back to the input.

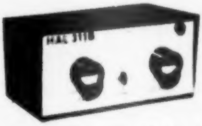
In many cases, both remedies are applied simultaneously. Increasing the feedback often permits a decrease in loading of the resonant circuit (achieved by reducing coupling between the resonant circuit and the amplifier input, as by using smaller coupling capacitors), which increases the effective working Q.

One of the most frequent causes for oscillators turning balky is the effort to obtain maximum output power. An oscillator, whether crystal or variable, is intended only to establish frequency. Once the frequency is established, its power level can be amplified as much as you like by ordinary amplifiers. If oscillators are not expected to furnish power, they usually behave beautifully.

Before we move on to take a look at crystals, let's see what starts an oscillator.

Remember, so far we have assumed that it was already going, and have looked only at the mechanisms which keep it going once started. However, it's obvious that any practical oscillator does not run all the time. When power is turned on, it has to start. How does this happen?

We make it happen, by using grid-leak bias rather than fixed bias on the oscillator. This assures us that when we turn the power on, the amplifier portion of the oscillator



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will (at least in the first few instants) be operating without bias, and so will be able to amplify signals.

When we turn on the power, this act in itself puts a pulsed signal into the power lines to the amplifier stage as the power supply voltage comes up from zero to its operating value. This signal pulse causes the resonant circuit to "ring." Even without the pulse caused by power turn-on, an amplifier always has some random noise in it, and this too is amplifier. Any noise pulses which happen to be near the frequency to which the resonant circuit is tuned will also cause ringing, so that we can always count on at least a little bit of action in the resonant circuit.

As the amplifier stage warms up and comes to life, any ringing in the resonant circuit provides it a small amount of input, and this input is amplified. Since (for safety) we included a little more feedback than was absolutely necessary, the fed-back portion of this amplified input is larger than was the original input level. It continues to build up in this manner, until the amplifier begins to draw grid current. At this point, the grid current establishes a bias voltage across the grid leak and sets up the operating bias voltage. Amplification continues, but the oscillator is running now. When the signal is limited by the available supply power, full Class C operation of the amplifier part of the circuit is going on.

While all this is happening, the frequency of the signal changes. Once stable operating conditions are reached, the frequency settles down. The change in frequency during the start and stop portions of the oscillator's operation cannot be avoided; some of it comes from actual physical changes in circuit elements such as expansion due to heating from the rf current flowing, and some is more exotic in origin–it comes from the change in phase of signal through the amplifier as operating voltages are changed.

Even those most stable of practical oscillators, the crystal circuits, are not immune to these changes. But crystal oscillators are, in themselves, the subject of a different question. Let's move on to that one.

Why Use Crystals? The vast majority of amateur transmitters, and an appreciable fraction of the receivers as well these days, make use of at least one crystal-controlled oscillator in some stage. Our question now is simple–why?

Most of us probably know, of course, that the crystal controlled oscillator is normally much more stable than a variable widely used whenever accurate and stable control of frequency is desired. But why should this be so?

To begin our look at the reasons why, let's back way, way off for a moment and observe that virtually everything we do with electronics depends to a pretty large degree on geometrical relationships among physical objects. A vacuum tube, for instance, gets its amplification because of the ratio in spacing and in area of the grid structure and the plate. A capacitor's capability to store energy is determined by the area of its plates and the spacing between them, as well as by the "dielectric constant" of the insulating material (which is, itself, determined by the molecular geometry of the material). An inductor's inductance is determined by diameter, spacing, and number of turns, all of which are physical quantities. The list goes on, and includes almost all of our components.

What's more, when we make use of the *electronic* results of these physical relationships, many relatively small physical changes introduce large changes in the results. The movement of a metal diaphragm changes the resistance of carbon grains enough to make the carbon microphone practical, but this movement is so slight that you can't see it with the naked eye.

The crystal oscillator gets its frequency stability primarily from the fact that it uses *physical* resonance rather than *electrical* resonance. This eliminates one whole level of relationships from physical to electrical and back again.

The material most often used for frequency-controlling crystals is quartz. Crystalline quartz shares with many other substances an interesting property known as "piezoelectricity," which means that it is capable of producing electricity in response to physical pressure, and conversely of changing its shape under the influence of electrical pressure; of all the piezoelectric substances, quartz crystals are the most durable and because of this have come into wide use.

When an alternating voltage is applied across the proper faces of a quartz crystal, the crystal will vibrate. The frequency at which the vibration occurs depends only upon the dimensions of the crystal. If the applied ac voltage happens to be at a frequency at which the crystal is mechanically resonant, though, the exchange of energy between the electrical and mechanical stages (and back again) is extremely efficient and very little energy is dissipated within the crystal.

This small energy dissipation means that the Q factor of a crystal (we'll quit pointing out that we really mean "quartz crystal" every time from here on) is high. Astronomical might be a better word. Typical Q figures for crystals range from 10,000 to 100,000; a *good* LC resonant circuit might reach a Q of 500 with extreme care in design and generous amounts of luck.

The natural form of crystalline quartz is a six-sided prism, looking something like **Fig. 2**. If we slice it straight through the middle and look at it end-on, we will find a hexagonal shape like **Fig. 3**. If we then join the midpoints of each pair of opposite flat sides with lines (Y1, Y2, and Y3 in **Fig. 3**) and the vertices at which the sides meet with other lines (X1, X2, and X3), we can establish three pairs of axes (axises, if you prefer); a third axis is provided by the crystal's center line where all the other axes meet, and it is called the "Z axis." These X, Y, and Z axes are established to guide the cutting of the "mother crystal" into blanks having the desired electrical properties. If a blank is cut so that it is perpendicular to the X-axis, it is known as an "X-cut" crystal, and similarly a Y-cut blank is one perpendicular to any one of the three Y axes. At

Fig. 2. Ideal quartz crystal is six-sided prism. Most natural crystals are imperfect, with chipped or broken edges or ends. Illustration shows an ideal crystal. Z-axis of the crystal is the line through the center of the crystal, the long way; in this one it would pass through the point at each end.

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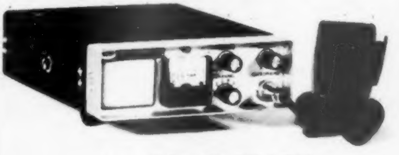

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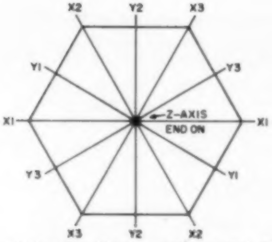

Fig. 3. Slicing the ideal quartz crystal of Fig. 2 across would give this hexagonal cross-section. Z-axis now is vertical to the illustration, protruding straight up from center of section. The six lines joining side midpoints (Y1, Y2, and Y3) and side corners (X1, X2, and X3) show the X and Y axes of the crystal. All the X axes are alike, and all the Y axes are alike, but blanks cut with X-axis orientation differ greatly from those cut across the Y-axis. Most crystal blanks are cut at an angle to all three axes to obtain the desired characteristics. Fig. 4 lists the "standard" cuts by common name and military designation.

least 11 "standard" cuts exist, and today neither the plain X-cut, Y-cut, nor Z-cut is considered standard. **Fig. 4** lists the 11 cuts designated as "standard" for military use; the differences between them are all caused by the different angle made between the plane of the crystal blank and the major axes of the original natural crystal.

As listed in **Fig. 4**, the crystal can vibrate in any of five modes depending upon its cut. Actually, a surprising number of crystals cut to vibrate in one mode will vibrate in not only the design mode but several others, and many will vibrate at a number of different frequencies. This fact is used in the design of "overtone" crystal oscillators, which are designed to operate at some vibration mode other than the lowest-frequency mode inherent in the crystal's dimensions.

COMMON DESIGNATION	VIBRATION MODE	MILITARY DESIGNATION
AT CUT	THICKNESS SHEAR	A ELEMENT
BT CUT	THICKNESS SHEAR	B ELEMENT
CT CUT	FACE SHEAR	C ELEMENT
DT CUT	FACE SHEAR	D ELEMENT
+5° X CUT	EXTENSIONAL	E ELEMENT
-18° X CUT	EXTENSIONAL	F ELEMENT
GT CUT	EXTENSIONAL	G ELEMENT
+5° X CUT	L-W FLEXURE	H ELEMENT
DUPLEX	L-T FLEXURE	J ELEMENT
MT CUT	EXTENSIONAL	M ELEMENT
NT CUT	L-W FLEXURE	N ELEMENT

Fig. 4. Designations of various types of crystal cuts. Military designation is the type number placed on crystal elements for military use. Vibration modes are shown in Fig. 5.

While the crystal's dimensions determine its operating frequency, it's not always the "thickness" dimension which turns out to be critical. Only the types which operate in the thickness-shear mode (**Fig. 5** shows the five vibration modes) are controlled primarily by thickness. The other cuts are influenced more heavily by the width or length of the crystal.

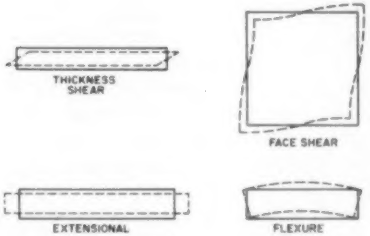

Fig. 5. Quartz crystals have several different "modes" of vibration, and the same crystal may be capable of vibrating in any of several modes (although manufacturers attempt to prevent this by grinding the crystal blank in such a way as to favor one mode to the exclusion of any others). In these drawings, the solid-line view shows the crystal's shape at rest, and the dotted lines indicate the shape at one extreme of vibration in the applicable mode. While most discussions of crystals action tend to leave the impression that vibration is in flexure mode, most common crystals actually use either thickness or face shear mode.

However, alteration of *any* dimension will change the resonant frequency to some degree. So, also, will changing the mass of the crystal; this can be achieved by "loading" the crystal surface with pencil lead or by rubbing solder into the surface. Plated crystals are adjusted to frequency by controlling the thickness (and so the mass) of the plated-on electrodes.

Once the basic vibration frequencies of a blank are established by grinding or etching to final dimensions, and proper precautions against excitation of the unwanted modes are built in so that only one of the several possible frequencies is used, the crystal is ready for use in an oscillator. There, it replaces the resonant circuit as both the frequency-determining element and the energy-storage device. Most variable or LC oscillator circuits have their crystal counterparts, which we will examine later.

At the moment, though, we're still looking at the reasons for the extreme frequency stability of the crystal. Its astronomical Q is the primary reason, and the relative freedom from effects of the surrounding environment is a strong supporting cause.

The crystal, however, is not a primary frequency standard. It can lose its stability, especially if mistreated. The more its motion during a cycle, the less stable it is. The greater the ac current through the crystal, the greater will be the motion. The higher the feedback fraction, the more current can flow. Thus excessive feedback can produce frequency instability. It can also do other things we'll look at during our next question.

Since the crystal operates with mechanical resonance and physical vibration, but converts the physical vibration into electrical signals, it acts just as if it were an exceptionally high quality resonant circuit. **Fig. 6** shows the schematic of the equivalent circuit of a crystal; the values are those typical for a 7 mhz AT-cut fundamental crystal approximately 1/10 inch thick and 3/8 inch square, which includes a Q of approximately 25,000.

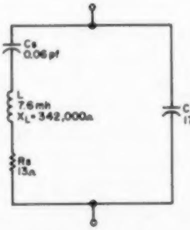

Fig. 6. Equivalent circuit of a typical 7 mhz quartz crystal 1/10 inch thick and 3/8 inch square. All quartz crystals show the same electrical characteristics, but the values given here apply only to the particular crystal element for which they were calculated. Note extremely large equivalent inductance and small series capacitance; large shunt capacitance helps account for stability, since several picofarads additional stray capacitance will have relatively little effect. Q of circuit equals inductive reactance divided by series resistance, or in this case 342000/13 which works out to a little more than 26,000.

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What Limits The Use of a Crystal Oscillator? The extreme utility of the crystal oscillator is proven by its wide use. SSB transmitters use them to provide the original carriers, vhf transmitters employ them for frequency control, many mobile rigs are rockbound, and not a few receivers make use of crystal-controlled front ends together with variable intermediate-frequency tuning to obtain top performance. But the crystal oscillator does have limitations; what are they?

Foremost of the limitations is the relatively low power capability of a crystal oscillator. So long as the oscillator is used only to establish frequency, and power generation is left to other parts of the equipment, this causes no problems. But when the maximum of power is required from the minimum of stages, the power limitation may rear its many-fanged jaws.

This limitation stems directly from the inherent fragility of any crystal. Just as Caruso was able to shatter a wine-glass by singing a sustained note at the glass's resonant frequency, so will the quartz crystal shatter if driven hard enough at its own resonant frequency. The excessive drive causes the crystal to bend farther than its strength will permit, and the result is a fractured frequency-controller.

Long before actual destruction of the crystal occurs, though, the stability of the oscillator will disappear. An overdriven crystal heats internally, and the heat causes the dimensions to change. Although the change is microscopic, it's enough to move the frequency several dozen cycles per megacycle.

A crystal which has been abused in this manner may not return to its original frequency for several hours or even several days after the drive has been reduced, either. Occasionally, the change in frequency is permanent.

The preventive, of course, is to keep crystal current as low as possible while assuring active oscillation. Crystal current is controlled by feedback; the less feedback, the lower the crystal current. For maximum stability, feedback should be just great enough to assure that the oscillator starts every time. In the grid-plate circuit, feedback is controlled by capacitor C1. In other circuits, it may be necessary to modify other circuit constants such as plate voltage to control feedback.

Crystal current may be measured by connecting a low-current pilot bulb, such as a 60 ma 2-volt bulb, in series with the crystal. Most crystals, except for fragile high-frequency fundamental blanks, can withstand 60 ma for short periods of time, and so the bulb serves double duty as both current indicator and fuse. The objective should be to keep the bulb as dim as possible while maintaining reliable starting characteristics on the oscillator.

Most crystal oscillator circuits in use today are of the electron-coupled variety, making use of a pentode tube in which the screen grid serves as the virtual plate of a triode tube in the oscillator circuit. This permits the actual output to be taken from the pentode plate circuit with minimum loading of the oscillator itself, and also permits the plate circuit to be tuned to the crystal frequency with the least possible effect upon the oscillator's action.

If electron coupling is not used, tuning the plate circuit to the exact frequency of the crystal may prevent oscillation, by shifting phase of the feedback current far enough away from 180° so that the feedback fraction times gain, at the frequency where 180° phase shift is present, is less than 1. In such cases the plate circuit must be turned slightly off-frequency for reliable, stable operation. Most often, the plate circuit should be tuned to a frequency *above* that of the crystal. Feedback voltage (and crystal current) in such a case will vary with plate tuning, and the adjustment should be made to a point which provides the minimum amount of crystal current necessary to provide reliable starting. This will provide maximum frequency stability.

Can The Inductors Be Left Out? All of the oscillators we've examined so far in this installment make use of a resonant circuit (either LC or the physical equivalent, a crystal) for frequency control and energy storage. However, the resonant circuit is not absolutely necessary.

The most popular type of high-performance audio oscillator, for example,

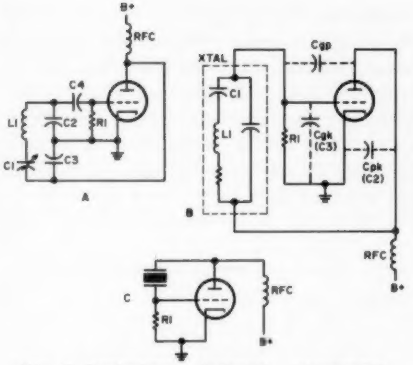

Fig. 7. Equivalence between non-crystal Clapp oscillator circuit (A) and Pierce crystal oscillator circuit (C) is shown here. By substituting the crystal's equivalent circuit from Fig. 6, as at B, we find that two circuits are almost identical. Grid-cathode capacitance of tube serves as feedback capacitor C2, while plate-cathode capacitance provides equivalent of C3. C4 is not necessary in either circuit. Crystal's shunt capacitance merely bypasses the resonant circuit slightly. Crystal's series resistance is also present in coil at A, although it is not shown, since any coil has at least some resistance present.

As shown in **Fig. 7**, we can replace the resonant circuit in a Clapp LC oscillator (**Fig. 7A**) with a crystal, and we have the Pierce circuit (**Fig. 7C**). Similarly, we can develop the grid-plate crystal circuit (**Fig. 8A**) from the Colpitts (**Fig. 8B**).

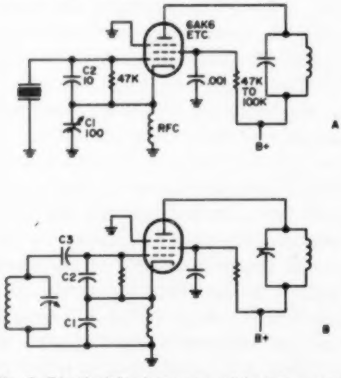

Fig. 8. Similarities between grid-plate crystal oscillator circuit (A) and Colpitts vfo circuit (B) are even more evident than are those shown in Fig. 7. Crystal in this case substitutes directly for resonant circuit, with no need for a dc blocking capacitor (C3 in B). Values shown in A are typical; similar values may be used in circuit at B but care must be taken to assure that resonant circuit Q is great enough to permit oscillation.

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In both the Pierce and the grid-plate crystal oscillator circuits, the crystal serves as a parallel resonant circuit. However, as may be seen from **Fig. 6**, every crystal has both a series resonance and a parallel resonance near its fundamental frequency, and some oscillator circuits are designed to make use of the series resonance although most of the popular circuits use the parallel-resonant mode.

In a series-resonance crystal oscillator circuit, the crystal is connected as a series element in the feedback circuit. Most such circuits require more components than parallel-resonant oscillators, as well as requiring tuning of additional circuits (since the series resonance does not lend itself to providing the necessary energy-storage capability). **Fig. 9** shows the Butler overtone oscillator circuit, which is one of the most popular series-resonance oscillators. This circuit uses either the fundamental, third, fifth, seventh, or ninth overtone of the crystal, depending upon the tuning of the parallel-resonant circuits in the plate circuits. Using a crystal ground especially for 7th-overtone operation in this circuit, it is possible to produce direct output at 144 mhz without frequency multipliers.

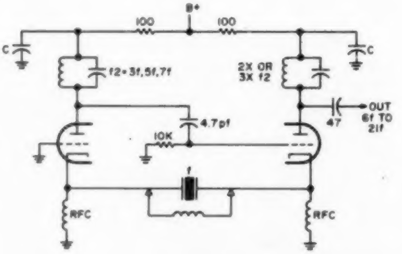

Fig. 9. Butler overtone oscillator circuit makes use of crystal's series resonance in feedback path. In consequence, additional resonant circuit is needed for energy storage. Stage at left acts as grounded-grid amplifier, with its output coupled to cathode-follower stage at right. Crystal in signal path from cathode-follower output to grounded-grid input filters out any signals except those which excite series-resonant vibration capacitance of crystal and holder to parallel resonance and thus remove it from the effective circuit. Cathode follower stage serves extra duty as frequency doubler or tripler to provide output at up to 21 times crystal's fundamental frequency (7th overtone, tripled).

contains no resonant circuits. Instead, as **Fig. 10** shows, it makes use of two feedback networks rather than just one. One of these feedback networks provides the positive feedback necessary to sustain oscillator action. The other network is frequency sensitive, and is connected so as to produce negative feedback.

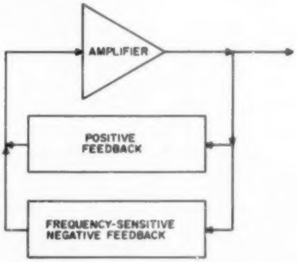

Fig. 10. Inductors aren't always necessary. Paired feedback networks as shown here may be used instead. If the negative feedback network is frequency sensitive so that feedback is reduced at one specific frequency, then circuit can oscillate only at that frequency. At any other frequency, negative feedback will cancel out the positive feedback and circuit can only amplify.

Because of the frequency sensitivity of the second network, the amount of negative feedback present depends upon the frequency of the signal. At almost all frequencies *except* the one at which oscillation is desired, there's enough negative feedback to cancel out the positive feedback from the first network, and the circuit is just a complicated amplifier.

At the desired operating frequency, though, the negative feedback is less. Some of the positive feedback remains; when the circuit is properly adjusted, the positive feedback left after the partial cancellation is still enough to sustain oscillation. The result is that the circuit is capable of oscillating at one and only one frequency; and any harmonics which might be produced in the process are reduced by the negative feedback.

Oscillators based on this principle are capable of providing sine waves in the audio range with less than 0.1% total distortion. Since no inductors are present, the frequency range over which such a circuit can be tuned is much greater (typically 10-to-1, compared with a 3-to-1 figure for the normal

L-C tuned circuit oscillator). Circuits which are based on this principle include the Wein bridge oscillator, the Twin-T oscillator, and the Bridged-T oscillator. Unfortunately, while the principle remains valid at radio frequencies, the feedback is much more difficult to control properly at high frequencies and so these oscillators have a typical upper-frequency limit of about 200 khz.

Not all oscillators produce sine waves, and most oscillators which produce non-sine waveforms are based on principles other than the resonant circuit. One of the most basic types of non-sine-wave oscillators is the multivibrator.

Whole volumes have been writen on the subject of multivibrators, and most discussions of them are sprinkled with detailed design equations which make the subject appear to be difficult to understand. Underneath it all, though, the multivibrator follows the basic principle of any oscillator as diagrammed in **Fig. 1**. It contains both amplifier and feedback sections. The problems emerge because of the difficulty in separating the two sections when a multivibrator schematic is examined.

The first problem appears when an attempt is made to isolate the "amplifier" part of the circuit. All multivibrators include not just one, but two amplifier stages. These stages may or may not be mirror images of each other, but they are connected so that each gets its input from the output of the other. So far as any signal within the circuit is concerned, the path of its flow is a closed ring.

We can give a ring a half-twist and turn it into a figure-8 pattern, and the various types of multivibrator circuits begin to show their similarities and differences if we draw their block diagrams in such a manner. **Fig. 11** shows such block diagrams for the three major classes of multivibrators.

In each of these, the "amplifier" stages shown as triangles are considered to be dc amplifiers, with 180° phase inversion from input to output. The three classes are distinguished by the manner in which the ring is closed. We can close the ring through coupling capacitors at both output-to-input connection points, as shown in **Fig. 11A**; we

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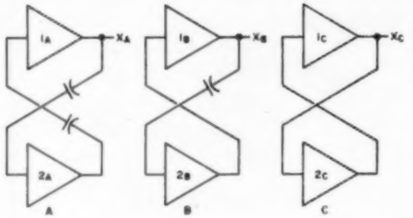

Fig. 11. Possibly the most widely used circuit in electronics today (although not so generally encountered in radio) is the multivibrator. Three types exist: astable (A), monostable (B), and bistable (C). Only major differences between types are in the manner of coupling stages. Astable has ac coupling only, monostable has one ac and one dc coupling, and bistable has only dc coupling. Only the astable is a true oscillator, but the bistable is the backbone of the computer industry and the monostable finds wide use as a timer. See text for details.

can use one dc connection and one capacitor as shown at B; or we can make both connections solid so that the dc path through the circuit is complete. These different connections give us three different types of circuit action.

In **Fig. 11A**, for instance, let's begin our examination with the assumption that the voltage at the input to amplifier 1A is at its lowest level. Since the amplifier has 180° inversion, the output will be at its highest level. If a change has occurred in this level recently, only the change will pass through the coupling capacitor. On emerging from the capacitor as the input signal to amplifier 2A, this rise in signal level causes the output of amplifier 2A to fall.

The fall is similarly coupled through the capacitor to the input of amplifier 1A to drive the level still lower. Eventually the limitations imposed by available power supply voltage will cause the output of 1A to stop climbing regardless of action at the input. No more changes can occur and everything levels off. However the capacitor coupling 1A's output to 2A's input is connected to high voltage on one side and to ground on the other, and so is charged. When circuit action levels off, the capacitor begins to discharge.

After a time delay determined by the size of the capacitor (which establishes how long it takes to discharge), the voltage at the input of amplifier 2A (which had been rising until things levelled out) begins to fall as capacitor discharge continues.

This fall in voltage at 2A's input appears as a rise at the output, and the rise in the output is coupled through the other capacitor to 1A's input. There it becomes an input signal for 1A, and causes the output level at point Xa to begin falling.

When the level at Xa begins to fall, the drop is coupled through the capacitor back to 2A's input. This accelerates the fall of the voltage level at 2A's input and drives the entire circuit to a levelling-off point exactly opposite to its previous condition, with 2A's output high and 1A's output low.

As soon as voltage change in the circuit reaches its limit in this direction, things reverse once again and the level at the input of 1A begins to fall. This brings us back to the point at which we started examining the circuit. We have gone through one complete cycle of multivibrator action. It will continue so long as power is supplied to the circuit.

Since both of the couplings in the ring are capacitive or ac couplings, the cirucit can never reach a "stable" condition but must continue vibrating from one state to the other. This circuit is called an "astable" multivibrator. Other names include "free-running" and, unfortunately, merely "multivibrator" or "multi." This is the only class of multi circuit which is capable of oscillating on its own—but the other two classes of multi circuits are of equal if not greater importance.

If we replace one of the capacitive ac connections with a solid dc connection as shown in **Fig. 11B**, for instance, we get a circuit which does have a stable state and so will not oscillate on its own.

For instance, as drawn here, the stable state provides a low-voltage level at point Xb. The input to amplifier 2B is low, which makes its output high, and this high-level output from 2B is connected directly to the input of 1B. In turn, the output of 1B is low. With voltage low on both sides of the capacitor, it is not charged. The circuit sits idle, doing nothing.

But if we momentarily insert a high-level input signal into amplifier 2B, this will drive 2B's output down to a lower level and since

1B's input follows right with it the signal level at Xb will begin to rise. The rise is coupled through the capacitor to 2B's input, causing 2B's output to fall even more. The momentary trigger input can be removed as soon as the internal signal gets all the way around the loop, because the feedback will take its place and drive the output of 2B as low as it can get. While this is happening, the output of 1B at point Xb rises.

Once 2B's output gets as low as possible it cannot change any more, and levels off. At this instant, Xb is at its highest level. Since the trigger signal is no longer present, there's a voltage difference across the capacitor, and discharge begins. As the capacitor discharges, the voltage at 2B's input falls. This causes 2B's output level to rise, which in turn drives Xb back down to a lower voltage.

Just as in the astable circuit, the action around the ring is cumulative and the voltage at Xb is rapidly driven as low as it can get. When it gets there, the output of amplifier 2B is at its highest possible level.

But unlike the astable circuit, when 2B's output goes to its high point the input to 1B is also high and *stays high*. There's no ac coupling there to force it to fall back down. And when Xb gets back to its low point to cause this, there's no voltage across the coupling capacitor, so everything is stable once again.

The result is that the momentary trigger input produces a single pulse at Xb. Since the duration of this pulse is determined almost entirely by the time it takes to discharge the coupling capacitor, the pulse's characteristics will be the same no matter how short the trigger input was.

This circuit, then, produces a single standardized output pulse for every input pulse it receives. The duration of the output pulse can be adjusted by choice of capacitor size and time constant. Such circuits are widely used to provide fixed time delays in the microsecond to multisecond range.

Because the circuit has one unstable state and one stable condition, it is known as a "monostable multivibrator;" other names include "one-shot" or "single shot."

If we replace both ac couplings with dc connections, as in **Fig. 11C**, we get a similar circuit but *both* states are stable. The signal

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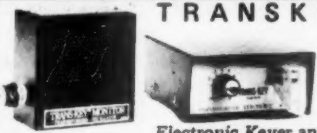

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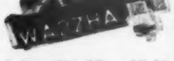

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at Xc may be high, or it may be low. Whatever its condition, the level at 2C's output will be the opposite level, and things will remain unchanged until something is done from outside the circuit to change them. Then they will remain stable in the new state, until something else is done to change them back.

For example, let's assume that Xc is at its high level. This holds 2C's output low because of the direct coupling, and 2C's output being low keeps Xc high.

If we can momentarily ground point Xc, or drive it down with a brief negative-going pulse, this will make 2C's input low and the output of 2C will go up. When 2C's output goes up, point Xc comes to its low level and stays there.

Nothing else happens in the circuit, until we hit Xc with a positive-going pulse from outside. This increase in level at 2C's input drives the output of 2C down, and starts Xc moving up. The rise at Xc, coupled back through 2C's input, drives 2C's output still lower, and the cumulative action switches the circuit back to its original stage.

This "bistable" multivibrator circuit appears to be far removed from an oscillator, but as **Fig. 11** shows, the only difference is a couple of capacitors. The circuit provides a "memory" since its two states may be used to "remember" some previous condition. Under its more popular name of "flip-flop" it's the backbone of the computer industry.

Now that we've gone through the basic multivibrator action and watched it perform in all of the three classes of multi circuits, we ought to take a little closer look at the points which establish the timing of the astable and monostable varieties.

As we have seen, the timing depends critically upon the charge and discharge of the coupling capacitors in the circuit. They are, in fact, frequently called "timing capacitors."

The fundamental operating range of a multi is determined entirely by the timing in the coupling circuits–but this timing is itself influenced by many factors.

The capacitance itself is the primary factor, but the time constant is just as much affected by the circuit resistance as by the capacitance. Most usually, capacitance is used to select a major timing range, and the resistance is then adjusted to provide a fine-tuning of the time constant.

Timing is also affected by the operating voltages supplied to the circuit. The higher the voltage, the smaller the portion of the discharge curve which will be used.

While the multivibrator's fundamental timing is established by the time constants of its coupling networks, the actual operating frequency for a multi can be changed over a relatively wide range without adjusting time constants. This is done by synchronizing the multi to some other signal.

Because the action in all multis depends upon a trigger signal (in the astable circuit, the trigger signal is provided internally by capacitor discharge; the monostable requires one external trigger but provides its own second trigger internally; the bistable requires that both triggers be external), a switch from one state to the other can be made to occur "early" by injecting an external trigger near the end of the multi's "normal" cycle. This external trigger touches off the switchover without waiting for capacitor discharge to provide an internal trigger.

If the trigger-signal level is properly chosen, it will affect the circuit only near the end of the normal cycle. This means that the trigger signal may be applied at a frequency as much as 10 times that of the multi, and the first 9 triggers during each multi cycle will be ineffective while the 10th one triggers off a new switchover. The multi then becomes a frequency divider; this is one of its most frequent applications in ham radio.

For instance, triggers may be developed from the output of a 100-khz crystal oscillator and applied to a 10 khz multi. The multivibrator will then be locked in frequency to the crystal. More triggers can be developed from the 10 khz multi output, and applied to another 1 khz multi. The process can be continued as long as we like. All the intermediate signals we get will be of the same frequency accuracy and stability as our original 100 khz signal.

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needs—but this is a matter of choice, not a situation dictated by limitations of the basic idea.

The monostable may be synchronized in the same fashion, because most practical monostable circuits ignore any triggers which arrive during the unstable period (the circuit of Fig. 11 will not necessarily do so, being simplified to the absolute essentials). The monostable, in fact, is more reliable as a frequency divider than is the astable, because an astable multi will keep running if the sync signal disappears. The monostable, on the other hand, produces output signals only so long as the input signal is present. This lets you know that any signal you have is accurate; with an astable divider, failure of the 100 khz signal would give you no indication of failure—but the multi's output signal might be almost any frequency, rather than 10 khz.

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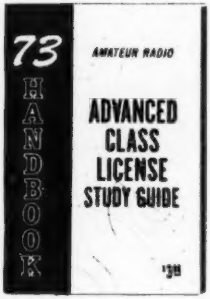
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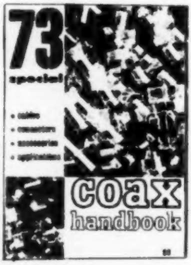
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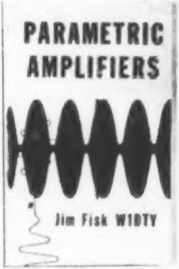
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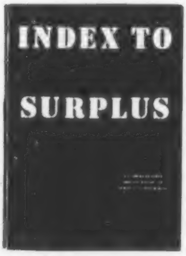
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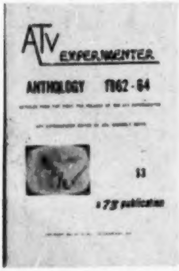

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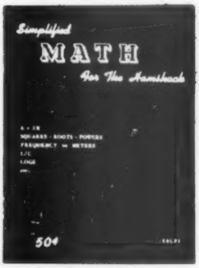

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Topographical Maps for the Radio Amateur

Charles Klawitter W9VZR
4627 N. Bartlett Avenue
Milwaukee WI 53211

For those of you who are not familiar with this fine addition to the resources of the radio amateur, allow me to formally introduce you. "A topographic map is a graphic representation of selected manmade and natural features of a part of the earth's surface plotted to a definite scale. The distinguishing characteristic of a topographic map is the portrayal of the shape and elevation of the terrain."[1]

"Topographic maps record in convenient, readable form the physical characteristics of the terrain as determined by precise engineering surveys and measurements. They show the location and shape of the mountains, valleys, and plains; the network of streams and rivers, and the principal works of man."[2]

These maps have many uses such as planning airports, highways, pipelines, transmission lines, and other construction. They are an old friend to the outdoorsman who may have discovered their advantages in such activities as hunting, fishing, or camping.

Why then, do I feel they are of importance to the amateur radio operator? Let me mention a few of the uses that I have experienced in the last several years. These maps do an excellent job of showing elevation and terrain. This would obviously suggest a simple method of finding a high spot for field day, a relay point for vhf and uhf equipment, a nice place to build a home and an antenna farm, and a good place to take the family for a ride and a picnic and possibly do a little hamming. They are very helpful in transmitter hunts, both for the hunter and the hunted. In emergencies, topographic maps can help your organization place its equipment quickly and in the most efficient location. These maps may help you to obtain a realistic idea of the capabilities of your uhf or vhf station or possible performance of your hf station on groundwave. I will discuss these applications more thoroughly later in the article.

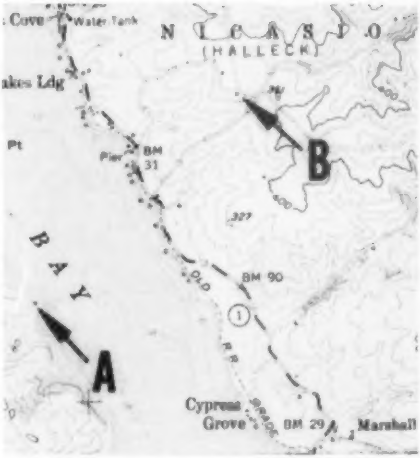

Fig. 1. Contour lines at 80' intervals.

As with any tool, it is no more effective than your ability to use it. I will attempt to provide you with a short course in the reading of topographic maps. In addition, you may want to send for the free booklet, "Topographic Maps," from the Map Information Office, U. S. Geological Survey, Washington, DC 20242.

I will relate to you those map skills

which will apply to an amateur's use of these maps.

Symbols are the graphic language of maps. Symbols for water features are generally printed in blue; man-made objects are shown in black and green is used to indicate wooded areas as opposed to clearings. Red is used to emphasize important roads, show built up urban areas, and public land subdivision lines. Symbols which show the shape and elevation of land surfaces are printed in brown. Some symbols of special concern to the amateur radio operator may be power transmission lines, boundries, swamps and roads.

The symbols which are of primary importance to the radio amateur are the brown contour lines which indicate elevation and are in turn an interpretation of the terrain. To understand the contour symbol, think of it as an imaginary line on the ground which takes any shape necessary to maintain a constant elevation above sea level. See **Fig. 1**. Remember, these maps are made from aerial photos, and you are always looking from directly above the terrain, but in real life you have a vertical or worm's eye view of the terrain. It may take you a while to get used to looking at these maps from a new perspective. The shoreline shown on the map illustration is a contour line representing zero elevation or sea level. If the sea were to rise and cover the land, the shoreline would trace out each of the contour lines shown on the map. It is just like when you sit in the bathtub, the water rises at an even rate. When you get out, the rings you leave behind are like the contour lines on the map. Try this next time when you are playing with your rubber duck and your battleship. Since the vertical difference in height between contour lines is 80 feet, the shoreline would coincide with a new contour line for each 80 feet that the sea rose.

For easier reading, index contour lines are added ususally every fourth or fifth contour line. They are accented by making the lines heavier. This will depend upon the contour interval. The contour interval is the number of feet that the elevation changes between concentric contour lines. In **Fig. 1**, it is 80 feet. This information can be found in the map margin. This will also tell you about the general elevation of an area represented by the map you are studying. For instance, if the contour interval is 5 or 10 feet, there is usually little elevation change, and it is a relatively flat area; if the contour interval is 50 to 100 feet, the map will represent an area of great elevation changes, mountains, ridges, valleys, etc. Figures in brown along contour lines give the elevations of the lines above sea level. The elevation at any point on the map can be read directly or interpolated. Therefore, point A in **Fig. 1** is 80 feet above sea level.

Another simple method of further interpreting elevation changes on topographic maps is illustrated in **Fig. 2**. Circle A indicates an area where the contour lines are very close together; this shows that the elevation changes quickly as it would on a steep ridge, valley or canyon. Circle B indicates an area where the contour lines have greater spacing; this shows that the elevation changes slowly as it would for a gently sloping hill. This information in conjunction with contour interval should make it possible for you to interpret terrain, primarily elevation change.

Also of aid in understanding and using these maps are the margins. The map margin is the space outside the projection

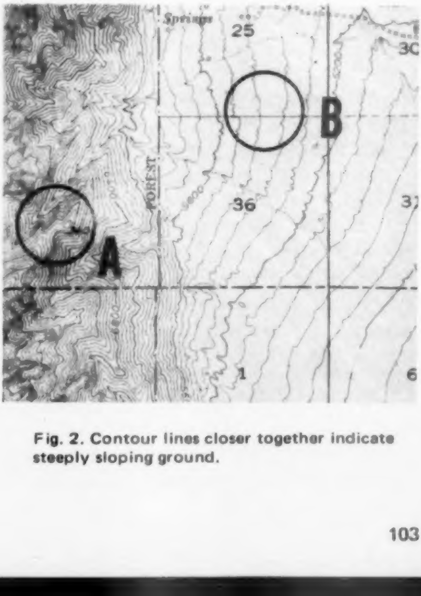

Fig. 2. Contour lines closer together indicate steeply sloping ground.

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lines of the maps. This space contains such useful information as the scale, contour interval, area covered by the map, and the date that it was last revised.

Now let us consider specific amateur radio uses for our new found companion. When considering field day or that family picnic, access to many areas can be determined quickly and accurately. Topographic maps far exceed road maps in detail and accuracy. Since they are at a larger scale, they often indicate roads or trails considered unimportant by makers of road maps. Rural areas are divided into townships which makes it easier to locate the owner of a prime transmitting and receiving area. Generally if you have information concerning townships and range lines, you can locate an owner by checking with the register of deeds, surveyor, or assessor of the township or county seat. Later you may even decide that you would like to purchase a particular piece of real estate because of its radio potential; DXCC, here we come!

For those people engaged in transmitter hunts, the afore mentioned ideas will also apply. If you are the hunted and are trying to place the hidden transmitter intelligently and slyly, consider placing it at the base of a steep ridge; at vhf frequencies you will obtain some weird effects. You might also consider a placement which would cause several reflections of the signal. This will really drive them nuts. The map will give you a panoramic view of area considered "fair game" for hiding the transmitter and will probably stir many ideas as you consider the overall picture presented to you.

Have you or your organization ever considered placing a vhf or uhf relay station? It is an efficient and reliable method of conducting communications over a short route. By checking the topographic maps, you may find that there are already some commercial installations in your area. Often they can be prevailed upon to allow you use of towers, buildings, and electrical connections as a public service. If not, you may be able to find an accessible location for the relay equipment. There may even be a fellow ham who already owns or lives at a location which is suitable.

How could you go about assessing your present location as a vhf or uhf site? Obviously, elevation is very important. How your location's elevation compared with your surroundings will greatly determine your ability to communicate. Here is one method which you could use to determine whether you could consistently communicate with another site several miles away. **Fig. 3** will illustrate what I mean. Suppose your location is point X and your friend's location is point Y. Draw a straight line between them. Follow this line carefully and check the elevation of the contour lines in between the two points. This will tell you what problems your signal will run into as it travels from point X to point Y. Depending upon distance between points, you may have to consider the curvature of earth, the type and height of antennas; you should be able to make some reliable prediction about your ability to communicate. This same procedure may be used for several different points at varied distances. You will soon have a pattern of communications. Now you should be able to pick out which stations you can work directly and which stations you may have to reach by relay. This method could also be very helpful to a group running a net. It should be possible to pinpoint that site which would be best suited as net control. This could save a great deal of time and cause a lot less net members to become discouraged because they have trouble communicating with the net control and receiving important net bulletins. Many of these same techniques can also be applied to hf groundwave capabilities.

All of the ideas I have already mentioned can be used to attack the most important problem; quick and efficient emergency communications. You should have previously prepared a map of the area you or your organization may have to serve in an emergency. Important point-to-point communication lanes should be marked and tested by on-the-air trials. Alternate routes should be available. Other important things which could be keyed to this map would be the locations for emergency power, hospitals and first aid stations, alternate routes for transportation, etc. These maps are inexpensive enough so that each member of an organization could have one in his car and/or home. They could make the difference between lives lost or lives saved.

Now that I have convinced you that you really need some topographic maps to be an effective amateur radio operator, I will give you the necessary information to obtain them. Indexes showing published topographic maps in each state, Puerto Rico, and the Virgin Islands are available free on request to the U. S. Geological Survey, Washington DC 20242, or Federal Center, Denver CO 80225. The index of your state will show you how to obtain maps of your specific location. These indexes also contain lists of special maps, addresses of local map dealers and federal map distribution centers. An order blank and detailed instructions for ordering maps are supplied with each index. To give you some idea of how inexpensive these maps are, one of your location which averages 18 inches by 36 inches in size, costs thirty cents when ordered individually. That also includes postage. There are discounts when larger numbers of maps are ordered. I think you will have to admit, it's a very good deal.

. . . W9VZR

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1. *Topographic Maps*, Geological Survey.
2. *op. cit.*

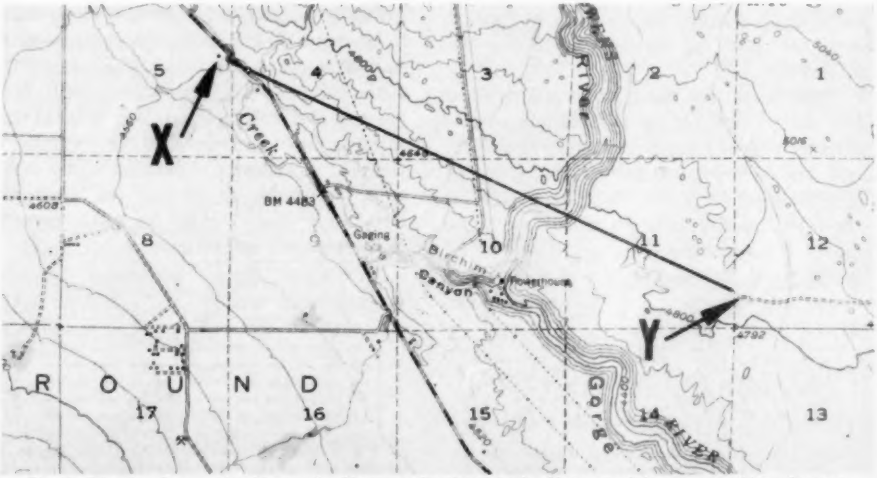

Fig. 3. The line from point X to point Y traces the signal path. Note possible sources of interference.

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Fascinating Fundamentals II:

Magnetism, The Mysterious Lodestone

It was a balmy spring day in the year 435 B.C. A sturdy ship made its way slowly across the water. The captain stopped pacing the deck and looked sleepily out at the towering mountains on the nearby island. Suddenly there was an ominous creak. Something flicked by the captain's ear, drawing a little blood as it went. Puzzled, he looked around. He opened his mouth in astonishment at the sight of three shields sailing through the air toward the distant island. A warning shout from behind, and the captain hit the deck as a sword whipped past his head. Looking up cautiously, he gasped as he beheld planks which had fallen from his ship bobbing in the wake. The awful truth dawned on him. He had sailed into the grip of the terrible Lodestone Mountain.

That looks like the start of a king-sized fish story, but the fact is, sailors of old actually believed such a mountain existed. It was one of the calculated risks of going to sea. So great were the magnetic powers of the fabled mountain that the nails would be drawn from passing ships, and they would disintegrate! This was typical of the legends concerning lodestone and magnetism in the days of yore.

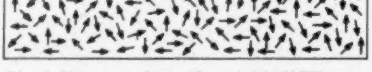

Fig. 1. When a piece of metal is NOT magnetized, the molecules all point in different directions.

Just when magnets were discovered, and by whom, is lost in antiquity. While the Chinese are known to have used magnetic compasses around 300 A.D., wild and wonderful tales of this mysterious force circulated around both the eastern and western worlds centuries earlier.

For instance, there was Magnes, a shepherd boy whose nailed boots and iron tipped spear were clamped to the ground. His name is thought to be the origin of the word Magnet

Or was it derived from Magnesia, a place where great quantities of this magical stone were found? Who knows?

For a long time, though, lodestone, a naturally magnetized mineral, was shrouded in mystery. In the west, the compass came into widespread use around the turn of the 13th century, but superstition still took priority over knowledge. It was believed that garlic would interfere with the compass. (I wonder how Marco Polo survived!) Also, while scientists agreed that the earth was flat, they knew that it had magnetic properties, and magnetic poles.

In 1269, Peter Peregrinus used a magnetized needle to discover the concentrated areas of power in a chunk of

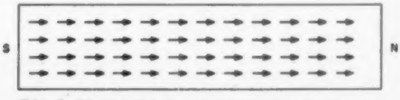

Fig. 2. Magnetizing causes the molecules to line up so that all their magnetic fields combine.

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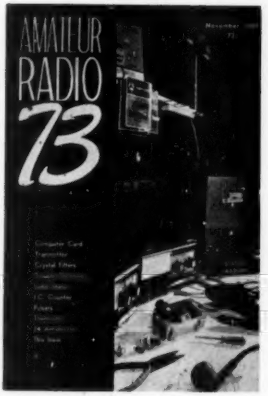

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Gift message:____________________

Number 2 1 year Jan. start

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Gift message:____________________

Number 3 1 year Jan. start

Name____________________

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Address____________________

City__________ State___ Zip______

☐ New ☐ renew ☐ who knows?

Gift message:____________________

More? Put on separate sheet.

lodestone. William Gilbert, in 1600, confirmed Peregrinus' findings, and pressed the theory that the earth itself was a large magnet.

Today there is still a lot that is unknown about magnetism, but scientists nonetheless have a pretty good idea as to how it works. There are only three elements which are strongly affected by magnetism; namely, iron, nickle, and cobalt. All other elements are either very weakly affected or not at all. The alloy, alnico, most widely used of all magnetic substances, is a mixture of aluminum, nickle, and cobalt.

In a magnetic substance the molecules can be pictured as if they were themselves tiny magnets. Normally, they are all pointing in different directions. But when the substance is magnetized, the molecules line up together so that their magnetic fields reinforce one another. Anything that will cause a disarray of the molecules, such as jarring or heating will weaken or destroy the magnetic powers.

You can easily magnetize a tool or other magnetic object with a magnet. Simply rub the magnet from one end of the tool to the other. Take the magnet away, and go back to the point where you began and rub the tool again. Several strokes like this, and the tool should be magnetized.There are two ways you could de-magnetize it. First you could heat it, but that would destroy the temper. Better still, hold the tool within the loop of a soldering gun tip, pull the trigger, and slowly withdraw the tool. The alternating current through the tip produces an alternating magnetic field which destroys the fixed order in the tool. Try it; it works.

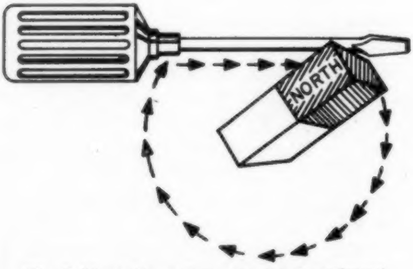
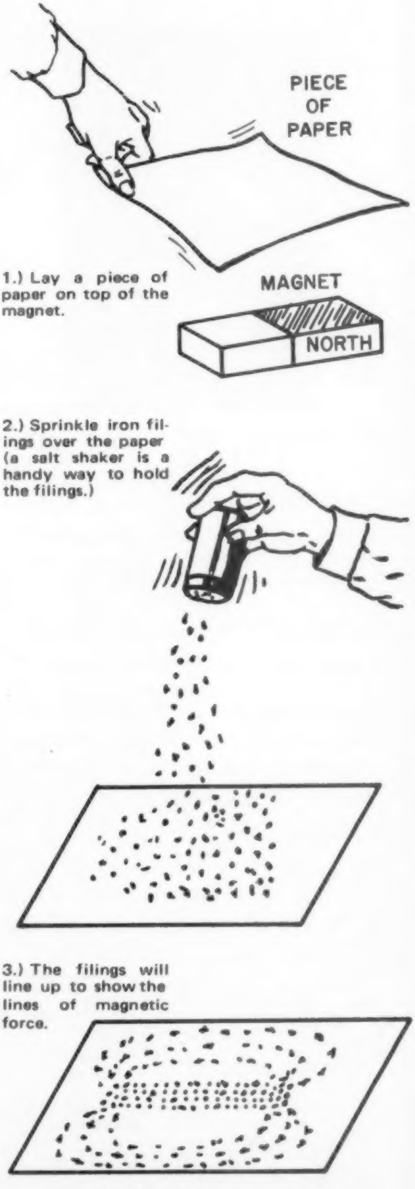


Fig. 3. Magnetic power can be transferred from the magnet to the screwdriver.

A magnetic field can be seen quite easily. Simply lay a sheet of paper over the magnet, and then sprinkle iron filings on the paper. The iron filings will line up in a very nice sketch of the magnetic field.



1.) Lay a piece of paper on top of the magnet.

2.) Sprinkle iron filings over the paper (a salt shaker is a handy way to hold the filings.)

3.) The filings will line up to show the lines of magnetic force.

Fig. 4. Sketching a magnetic field.

The ends of the magnet, or the points where the power is concentrated, are called the POLES. They are so called because, if you hang up a bar magnet and allow it to swing free, the ends will line up pointing north and south. If you bring two north-seeking poles together, they will repel each other strongly. If you bring a north-seeking and a south-seeking pole together, they will attract.

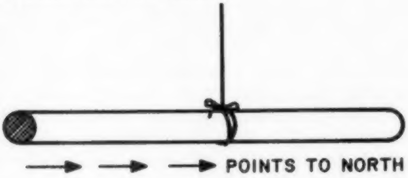


Fig. 5. A bar magnet, hung up so that it can swing freely, will point north.

The needle of a compass is really a small magnet. I remember once, as a Cub Scout, sticking a magnetized needle through a cork and letting it float. Sure enough, it turned around until it pointed north.

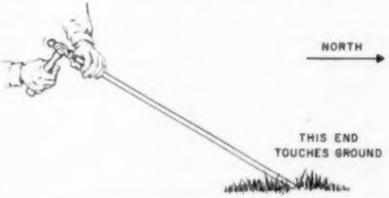


Fig. 6. To magnetize a steel bar, touch one end to the ground, point it north, and rap it a few times with a hammer.

Try this one. Take a long steel rod, point it north and touch one end to the ground. Strike the other end a few raps with a hammer. Now bring the rod close to a compass. When one end of the rod is brought near the compass, the "north" end of the needle will swing toward it. Turn the rod end-for-end, and the other end of the compass needle will point to it. That is iron-clad proof of magnetism. If you're lucky, it may even be strong enough to pick up a small pin. You will have magnetized the rod from the earth's magnetic field!

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FCC ANNOUNCEMENT

1. On August 24, 1967, the Commision adopted its Report and Order in Docket No. 15928 (FCC 67-978, 9 FCC 2d 814), which made the allocation of certain sub-bands as "incentives" exclusively to the Extra and Advanced Class amateur operator licenses. The first phase of these allocations went into effect November 22, 1968, and the second phase is scheduled to become effective November 22, 1969.

2. In its Report and Order, the Commission said: "Notwithstanding this schedule, the Commission intends careful review and if it is determined that there is insufficient occupancy of any part of the reserved frequency segments, then the effective date of the implementation schedule will necessarily be stayed in whole or in part, as appropriate." In its Order denying RM-1287, August 9, 1968, the Commission said regarding Docket No. 15928 that: "... it is its intention ... to make necessary changes if the effective utilization of the frequencies involved is threatened." In the same Order, it said: "So that Commission review may be meaningful, it is planned to gauge the results following each stage of implementation."

3. Three petitions and much correspondence have been received suggesting variations and counter proposals to the current rules and the scheduled frequency reservations. RM-1357, filed October 7, 1968, by Neil W. Petlock, proposed an advanced telegraph license which would require only a high speed code test to qualify for use of the Extra Class telegraphy allocations. RM-1393, filted January 1, 1969, by John A. Attaway, proposed that the exclusive Extra Class telegraphy segments 7000-7025 and 14000-14025 khz not be expanded on November 22, 1969, and suggests that a reservation of a 10 khz instead of 25 or 50 khz would provide a better balance of band usage. RM-1493, filed August 6, 1969, by Emery T. Mitton, proposed that the Extra-Advanced exclusive sub-band 50.0-50.1 mhz be reduced to 50.0-50.05 mhz and a telegraphy only segment of the band be established at 53.5-54.0 mhz so as to be available to Technician Class operators.

4. The Commission has considered the abovementioned petitions and correspondence, occupancy surveys of the reserved sub-bands, and license statistics which show a definite shift toward the higher classes of licenses in reaching the following conclusions:

a. The exclusive telegraphy sub-bands for the Amateur Extra Class licenses are relatively lightly used compared to the telegraphy usage of the balance of the band by the other Classes of operators. Therefore, further expansion is not justifiable as a productive incentive to qualify for the Extra Class license at this time.

b. The telephony sub-bands reserved for exclusive operation of Advanced and Extra Class licensees are so well used during periods of moderate and heavy amateur activity that the previously adopted further expansion is necessary for the purpose of providing a continuing incentive to qualify for these classes of licenses. Comparison of the current number of licensees of each class and the space available to them in each of the four amateur high frequency telephony bands under consideration confirms the need for such adjustment. Therefore, the telephony allocations in the 3.8, 7.2, 14.2, and 21.25 mhz bands will go into effect on November 22, 1969, exactly as previously adopted by the Commission on August 24, 1967.

c. The interest in, and use of, the current space reserved for Advanced and Extra Class operators between 50.0 and 50.1 mhz is so moderate that the further expansion to 50.00-50.25 mhz scheduled for November 22, 1969, is unwarranted.

5. In reaching the above conclusions, the Commission has given consideration to the proposals advanced by the petitioners. The proposal of Mr. Petlock (RM-1357) is not consistent with the Commission's intent to encourage a balanced achievement at the highest level, both in code and technical ability, and is therefore denied. As noted above, further expansion of any of the four Extra Class exclusive telegraphy sub-bands is not justified by the present level of activity. However, a reduction at this time from the present 25 khz segments as proposed by Dr. Attaway (RM-1393) would not be consistent with the desirability of continuing an incentive to qualify for the Extra Class license. Accordingly, his petition is granted to the extent provided herein and denied in other respects. In view of Mr. Mitton's statement (RM-1493) that the 50 mhz band is very lightly occupied, and in the absence of any affirmative showing for a need to realign the frequencies in that band, his petition is denied.

6. In view of the foregoing, the Commission finds that the amendments to Part 97, Amateur Radio Service, as set forth in the attached Appendix, are in the public interest, convenience, and necessity. The authority for such amendments is contained in Section 4(i) and 303 of the Communications Act of 1934, as amended.

7. Accordingly, IT IS ORDERED, That effective November 22, 1969, Part 97 of the Commission's Rules IS AMENDED as set forth in the attached Appendix.

8. IT IS FURTHER ORDERED, That the petitions filed by Neil L. Petlock (RM-1357), John A. Attaway (RM-1393), and Emery T. Mitton (RM-1493), to the extent that they are at variance with the rule changes adopted herein, ARE DENIED.

FEDERAL COMMUNICATIONS COMMISSION
Ben F. Waple
Secretary

Appendix

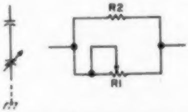
Part 97 of the Commission's Rules is amended as follows:

Section 97.7(a) & table, and par (c) [Note deleted] are amended to read as follows:

§97.7 Privileges of operator licenses.

Lowering Values

A quick method for lowering the maximum value of variable resistors and capacitors is shown in the illustration. The simple parallel combination of resistor and pot will restrict the upper resistance value of the pot. With a 1 meg pot and a 1 meg shunt resistor, the maximum total resistance of the combination will be held to 500K. The only disadvantage of this circuit is that the linearity of the pot (if it was linear to begin with) will be destroyed, but this isn't too serious in amateur work. The shunt resistor should not be less than one-tenth the value of the pot for smooth operation. All of the above applies to capacitors except that a series combination is used. By using the parallel resistance or series capacitance formulas in a slightly modified form you can determine the value of the shunt resistor or series capacitor. For instance, when the total resistance and the value of the pot are known, the value of the shunt resistor can be found by using the formula R2=RtR1 /R1-Rt where Rt is the total resistance. The same formula can be .used for capacitors in series. As an example, a 365/pf broadcast replacement variable can, in effect, be turned into a 100/pF variable by soldering a 140 pF fixed capacitor in series with it.



. . . **Charles Jimenez WA4ZQO**

(a) *Amateur Extra Class and Advanced Class.* All authorized amateur privileges including exclusive frequency operating authority in accordance with the following table.

Frequencies	Class of license authorized
3500 - 3525 kc/s 3800 - 3825 kc/s 7000 - 7025 kc/s 14000 - 14025 kc/s 21000 - 21025 kc/s 21250 - 21275 kc/s	Amateur Extra Only
3825 - 3900 kc/s 7200 - 7250 kc/s 14200 - 14275 kc/s 21275 - 21350 kc/s 50 - 50.1 Mc/s	Amateur Extra and Advanced

(c) *Technician Class.*
All authorized amateur privileges on the frequencies 50.1-54.0 Mc/s and 145-147 Mc/s and in the amateur frequency bands above 220 Mc/s.

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☐ 12-200V ☐ 3-1200V

1.5 AMP
☐ 18-50V ☐ 5-800V
☐ 15-100V ☐ 4-1000V
☐ 10-200V ☐ 2-1200V

3 AMP
☐ 15-50V ☐ 4-600V
☐ 10-100V ☐ 3-800V
☐ 8-200V ☐ 2-1000V
☐ 5-400V ☐ 1-1200V

5 AMP
☐ 10-50V ☐ 4-400V
☐ 8-100V ☐ 3-800V
☐ 6-200V ☐ 2-1000V
☐ 5-300V ☐ 1-1200V

8 AMP STUD
☐ 6-100V ☐ 3-400V
☐ 4-200V ☐ 2-800V

12 AMP STUD
☐ 5-100V ☐ 2-800V
☐ 3-500V ☐ 1-1000V

20 AMP STUD
☐ 4-50V ☐ 2-500V
☐ 3-100V ☐ 1-1000V

40 AMP STUD
☐ 3-50V ☐ 1-300V
☐ 2-100V

60 AMP STUD
☐ 2-50V ☐ 1-1000V

ZENER—DIODES
250-400 MW
1 EA 4V-6V-8V-10V

1 WATT
1 EA 4V-6V-8V-10V

2 WATT
12 to 60V
CHOICE OF THREE

3 WATT
10V 3- **$1.00**

10 WATT
12 to 60V THREE

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☐ 5-50V ☐ 3-200V
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☐ 3-100V ☐ 1-800V

20 AMP
☐ 2-50V ☐ 1-300V

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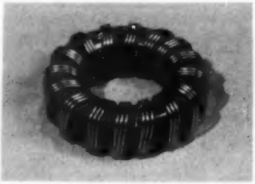
1970 Amateur Radio Buyer's Guide

The information compiled herein is as accurate as can be expected, considering that it was compiled by the editor during the short lulls between meals, coffee breaks, staff uprisings, hamfests, and hunting trips. The prices listed may or may not be accurate, probably. Possibly not. Ditto product specifications. We hope you will find the listing helpful, somewhat.

Antennas & Accessories

● Amidon Associates, 12033 Otsego, North Hollywood CA 91607



Toroid balun kit, either 4:1 or 1:1 ratio, for matching balanced to unbalanced lines, coas to twinlead, etc. Used for dipoles, quads, inverted vees, etc. $5 with complete instructions. Amidon also handles a wide range of toroid forms, send for list.

● Antenna Specialists, 12435 Euclid, Cleveland OH 44106. Mobile and base station antennas for 2-6-10 meters. Accessories for mobile whips.

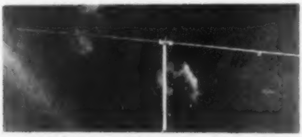
● Barker & Williamson, Canal Street, Bristol PA 19007. Coaxial antenna switches, coaxial dipole antenna connector, TVI low pass filters.

● Bilada Manufacturing, Box 263, Manasquan NJ 08736. Balun for dipoles.

● Cornell Dubilier, 50 Paris Street, Newark NJ 07101. Antenna rotators, Ham-M, AR33, etc.

● Cubex, Box 732, Altadena CA 91003. Cubical quads, 2-3-4 elements, 3 bands.

● Cushcraft, 621 Hayward, Manchester NH 03103. Yagi & collinear VHF beams, HF beams, mobile antennas, lightning arrestors, verticals, halos, big wheels, etc.



This is the Cushcraft Trik-Stik, a dipole that can be mounted horizontally or vertically and used for any VHF band, ¾ thru 10 meters, aircraft, weather, TV, FM, etc.

● Dow-Key, Box 265, Broomfield CO 80020. Coaxial switches and relays.

● Drake Manufacturing, Miamisburg OH 45342. High and low pass filters.

● Dusina Enterprises, 571 Orange Grove, Melbourne FL 32901.

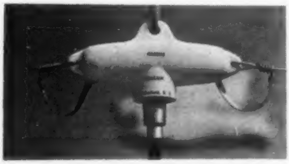
40 meter super gain antenna (see 73, October 1969). All you need are five 8' sticks and this antenna. $14.75 pp.

The Guerilla, 40/75M dual band 1 kw antenna. 50% power gain over dipole. Easy to erect. $33.75 pp.

● Gam Electronics, 191 Varney Street, Manchester NH 03102. Mobile and base VHF antennas.

Gotham, 1805 Purdy, Miami Beach FL 33139. HF beams, quads, verticals.

● O. Watson Greene, Wakefield RI 02880.



Coaxial center connector for dipoles, etc. Waterproofs and protects connection to the antenna from the feed line. With balun built in for matching balanced antenna to unbalanced feed $10. Without balun $6.

● Hi-Par, 347 Lunenburg, Fitchburg MA 01421. Mobile halos, VHF beams.

Saturn 6 mobile halo antenna, $17.

6MHT portable six meter three element beam, $14.

HT2M portable two meter 8 element beam, $17.

S4 bumper hitch, $3.

● Hirsch Sales, 219 California Drive, Williamsville NY 14221. Lightening arrestor. Zap-Trap, right angle connector-arrestor, $2.90.

● Hy-Gain, NE Highway 6, Lincoln NB68501. Beams, quads, verticals, dipoles, mobile whips, accessories.

● E. F. Johnson Co., Waseca MN 56093.

SWR coupler, 250-37, $11.75.
SWR indicator, 250-38, $25.
TR switch 250-39, $30.
275 watt matchbox 250-23-1, $65.

Matchbox with SWR indicator 250-30-3, $154.50.

● JSX Products, Box 47, Newberg OR 97132.

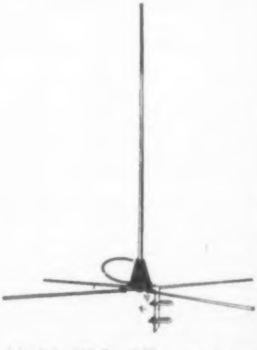
Hamster 2B compact antenna for 40-80 meters, $71.70 pp, complete in traveling case.

● Kirk Electronics, 6151 Dayton Liberty Road, Dayton OH 45418.

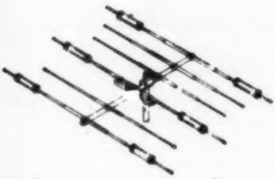
Fibreglass quads and components for quads.

● Lattin Radio Laboratories, Box 44, Owensboro KY 42301. All band doublet $35.00.

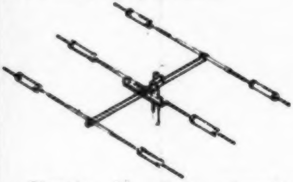
● Mosley Electronics, 4610 N Linbergh Bvd, Bridgeton MO 63042. Dipoles, beams, ground planes, accessories, verticals, etc.



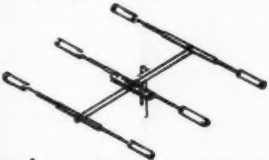
Model DI-2, 5/8 wave omnidirectional vertically polarized 2M ground plane. $10.58. 1 kw.



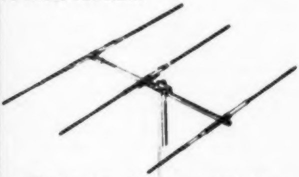
Classic 36, six element, 10-15-20M, 1 kw, $171.92.



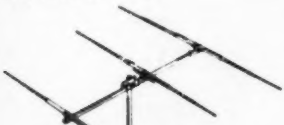
Classic 33, three element, 10-15-20M, $145.15.



Classic 10-15, three element, 10-15M, $107.15.

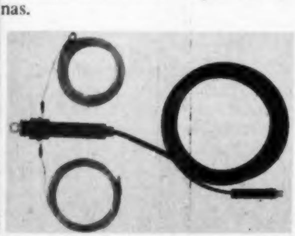


Classic 10, three element single band, $57.64.



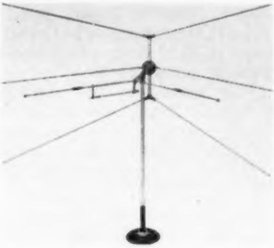
Classic 15, three element single band, $66.50.

● Murch Electronics, Box 35, Franklin ME 04634. Dipole antennas.



Fully adjustable dipoles and accessories. Models available for open wire line or coax line, 40 or 80 meters. Model 51-51-5, kw, 10-80 meters $34.50.

● New-Tronics Corp., 3455 Vega Avenue, Cleveland OH 44113. Antennas, mobile antennas, accessories.



Coveya 6 antenna, 10 db gain, kw, six meters, $39.90. Hustler mobile antennas for 10 thru 75 meters, folding fase sections, bases, springs, gutter clips, and a profusion of accessories.

Hustler II mobile antenna, shorter than 40", short enough for garaging, supplied complete from radiator to PL259 connector, installs in minutes without drilling, wire trimming, or soldering, for 10-05-20 meters.

● Omega T Systems, 300 Terrace Village, Richardson TX 75080.

Antenna noise bridge tests antenna system for resonant frequency and impedance, tests any type antenna, 1-100 mhz, $25 pp. The TE7-02 is an extended range model, covering 1-300 mhz, $35.

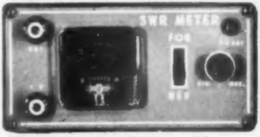
● Productos Joga, Calle 50 x 45 Num. 431, Merida, Yuc., Mexico.

Two element three band quad, handles a kw, single feed line, unique shape allows 4'6" boom length. Withstands 100 mph winds.

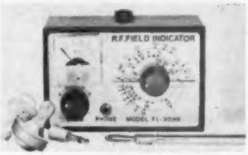
● Quement, 1000 S Bascom, San Jose CA 95128.

In line SWR bridge, kw, reads forward and reflected power simultaneously, $17 pp. SWR bridge and field strength meter, kw, good through two meters, $10.

● Redline Company, Box 431, Jaffrey NH 03452.



SWR meter, 1 kw, 52 ohms, model SE405, $16 pp.



RF field strength meter 1-400 mhz, with five section antenna and earphone for checking modulation, listening to carrier, magnetic base for mobile, model FL30, $9.50 pp.

● Skylane Products, 406 Bon Air Drive, Temple Terrace FL 33617. Quads.

Two, three, four, five and six element quads, one and three band quads, bamboo or fibreglass elements. Four element fibreglass 10-15-20M quad only $199.95.

● Swan's Antenna Co., Box 1122, Stockton CA 95201. Two and six meter beams.

Band pass is increased by using four driven elements. Two meter 11 element beam covers 143-149 mhz with 15 db gain, 12-1/2 foot boom, 6 lbs, $24.95.

● Swan Electronics Corp., 417 Via Del Monte, Oceanside CA. Mobile antennas.

Model 55 Swantenna, five band

remote band switching mobile antenna. About 8' high, 500 watts, 5-1/2 lbs, $95.

● Telrex Laboratories, Asbury Park NJ 07712. Antennas, I.V. kits, towers, accessories, etc.

Broad band baluns, inverted Vee antennas, antenna rotators, beams for all amateur bands from 3/4 meter through 40 meters (three element wide spaced beam, 177 lbs, under $900), two band, three band and even four band beams.

● Unadilla Radiation Products, Unadilla NY 13849. Quads, baluns.

W2AU navy type broad band balun, stainless steel hardware, full kw, 1:1 or 4:1 types, see page 49 for details.

● Waters Manufacturing, Wayland, MA 01778.

Coax switches, SP6T $14.50, SP5T $14, SPDT $13. Also mobile antennas and accessories.

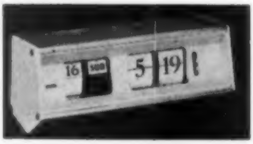
● Western Electronics, Dept. A, Kearney NB 68847. Antennas.

Clocks

● The Farmerie Corporation, 114 Spencer Lane, Glenshaw PA 15116.

● Pennwood Numechron Co., 7249 Frankstown Ave., Pittsburgh PA.

● Redline, Box 431, Jaffrey NH 03452.

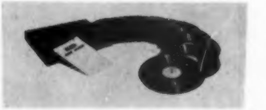


Calendar clock, available in 24 hour or 12 hour movements, self starting, indicates day or month and day of week, brushed aluminum, $40 pp.

Digital clock, available in 24 or 12 hour movements, cases in charcoal gray, coral red, light blue, white, brown, or clear plastic which shows mechanism clearly, $25 pp.

Code Records & Tapes

● Ameco, Box 6527, Raleigh NC 27608.



Code records for all license grades, code practice oscillators, books on learning code. 8-18 wpm record, $3.95, number 103-33. 104-33, supplement, $3.95. 104-33 from 13 to 22 wpm, $3.95. 106-33, 19 to 24 wpm, $3.95.

CW, a 50¢ book on how to learn the code using a new and improved learning system that has all the others beat a mile. Lays the foundation for developing truly high speed code ability.

● Epsilon Records, 206 E Front St., Florence CO 81226.

Revolutionary new word method code learning course. Three 12" records with 2-1/3 hours of instruction for only $9.95. Based upon modern psychological techniques. Available also on magnetic tape at $9.95 or on cassette for $10.95. This is a very easy way to get that 13 per.

● Heath Company, Benton Harbor MI 49022.

HDP-32 set of three code records, $9.50.

● Instructograph Company, 4700-Q Crenshaw Blvd., Los Angeles CA 90043.

● Pickering Radio Co., Box 29, Portsmouth RI 02871.

CM-1 5-7-9 wpm tape code groups and punctuation. CM-1-1/2 code at 11-14-17 wpm. CM-2 (for Extra Class) 20-25-30 wpm. Each tape about 90 minutes. $5.95 for one, $11 for two, $15 for all three, pp. Available on 7" reels at 3-3/4 ips or 3-1/4" reels at 1-7/8 ips, both two track.

● Rand Laboratories, Box 102, Winthrop ME 04364.

15 wpm tape, $5.49 for 3-3/4 ips 5" reel, complete with QRM, very realistic. Extra Class tapes (two hours) with 40 minutes each at 15-20-25 wpm, 20 minutes each speed sprinkled with QRM to prepare you for ugly reality, $5.49 pp.

● Hayden Book Company, Inc., New York NY.

Sight-N-Sound courses. Novice, $9.50, 0-8 wpm, 3 records. Advanced, $9.00, 9-20 wpm, 3 records. Complete course 0-20 wpm, six records, $16.

● Teleplex Company, 739 Kazmir Court, Modesto CA 95351.

Teleplex system with tone generator, $58. Without tone oscillator, $49.50. Code is recorded on drum, speed is infinitely variable.

Crystals and Calibrators

● American Crystal Co., 2366, Kansas City MO 64142.

● Crystek, 1000 Crystal Dr., Fort Myers FL 33901.

● Denver Crystals, Rte. 1, Box 357, Parker CO 80134.

● HAL Devices, Box 365L, Urbana IL 61801.

The HAL marker generator is a frequency divider requiring 3 vdc which can be arranged to provide 25 khz or 50 khz markers from a 100 khz crystal calibrator. For $4.95 it is shipped wired and tested with complete installation instructions.

● International Crystal Mfg. Co., Inc., 10 N Lee, Oklahoma City OK 73102.

● Jan Crystals, 2400B Crystal Dr., Ft. Myers FL 33901.

● Midwest Crystal Company, 1516 Parkwood Road, Cleveland OH 44107.

● Paxitronix Inc., Box 1038 (B), Boulder CO 80302.

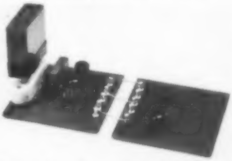
Gives you 25 khz markers from your 100 khz calibrator. Circuit board, $6.25 pp.

● Quaker Electronics, Box 215, Hunlock Creek PA 18621.

● The Radio Shop, 48 Elm St., New Canaan CT 06840.

Frequency marker kit, PC board, uses your 100 khz crystal, outputs on 100, 50, 25, 10 and 5 khz multiples up to 50 mhz, $15.00 pp.

● R & R Electronics, 311 E. South Street, Indianapolis IN 46225.



Crystal calibrator 100 khz, kit, PC board, battery operated, with crystal, $5.

Calibrator kit for 25 khz and 50 khz markers, harmonics to 50 mhz, $8.

● Sentry Manufacturing Co., Crystal Park, Chichasha OK 73018.

Precision quartz crystals and electronics for the Communications Industry.

● Nat Stinnette, Drawer Q, Umatilla FL 32784.

Desks

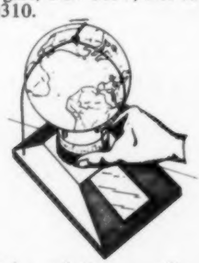
● Design Industries, Inc., Box 19406, Dallas TX 75219.

DX

- **Global Computations, Box 2245, Rockville MD 20852**

Beam headings computed for any place in the world. Send $4 with exact location and get a great circle bearing to over 500 locations, distance in miles or kilometers (please advise), return bearings, callsign prefix and time difference for each location. If you can't give your latitude and longitude, add .50.

- **Megart, Box 2097, Des Moines IA 50310.**



Globe plotter, small globe mounted to indicate bearing from your station to any part of the world. Reciprocal bearing can be found easily too, clever invention, $18 pp.

- **Montgomery Geodetic Services, Box 5707, Bethesda MD 20014.**

- **World QSL Bureau, 5200 Panama Avenue, Richmond CA 94804.**

The only QSL Bureau in the USA to handle for a fee outgoing QSLs to anywhere in the world including intra USA, Canada, and Mexico. Bureau operates in accurate, efficient manner, and has use of computers, postal stamping machines and mechanical equipment. Majority of QSLs are sorted, processed and mailed out within 48 hours of receipt. See page 131 for details.

- **73 Atlas, 73 Magazine, Peterborough NH 03458.**

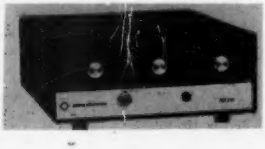
Engravers

- **Arnold's Engraving, 2041 Linden St., Ridgewood NY 11227.**

Personalized on the air sign, lights up, $12.95. Engraved tie call bars, station call plates, call pins.

FM

- **Galaxy Electronics, 10 South 34th St., Council Bluffs IA 51501.**



FM-210 FM transceiver, solid state, FET front end, 12-14 vdc, three channels, squelch, compressor, $199.95 plus $39.95 for a power booster.

- **ICE, 8507 Speedway, San Antonio TX 78230.**

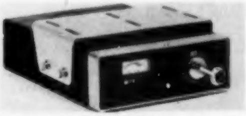
ICE-2 two meters FM transceiver, three channels, built in power supply, 4 watts, $285. ICE-6 six meters, same as ICE-2 otherwise. Nicad battery and charger $47.

- **K-N Electronics, Inc., 107 Moorewood Ave., Avon Lake OH 44012.**

- **Newsome Electronics, 19675 Allen Road, Trenton MI 48183.**

Surplus FM equipment, particularly Motorola.

- **Standard Communications, Box 3727, Torrance CA 90502**



Solid state FM transceiver, 12 channels, 5 watts, $300, 10 watts, $335, both for two meters.

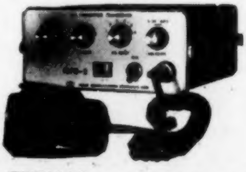
- **Two-Way Radio Engineers, Inc., 1100 Tremont St., Boston MA 02120.**

Motorola FM schematic digest $3.95 pp. Schematics, crystal information, alignment instructions, service hints.

- **Vanguard Electronic Labs, 196-23 Jamaica Ave., Hollis NY 11423.**

FMR-150 FM monitor receiver. Dual gate MOSFET front end for very low noise, minimum cross-talk, squelch, 12 vdc, four channels $69.95. Plus two and six meter converters.

- **Varitronics, Inc., 4109 N 39th St., Phoenix AZ85018.**



FDFM-2S two meter transceiver, 10 watts solid state, six channels, 12 vdc, $310. Two watt model $250.

- **VHF Associates, Box 22135, Denver CO 80222.**

FMT-1 two meter FM transceiver, all solid state, 13.5 vdc, six channels, $289.95.

Keys & Keyers

- **Digi-Key, Box 27146, Minneapolis MN 55427.**

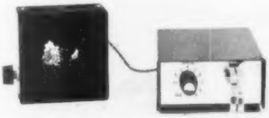
Solid state, 5-50 wpm, self completing, for grid block rigs (optional relay available), $15 pp.

- **Electrophysics Corp. 898 W 18 St., Costa Mesta CA.**

Autronic Key, $20; Autronic Keyer, $80.

- **Global Import Co., Box 246, El Toro CA 92630.**

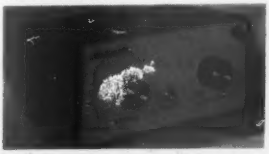
Transkey Senior ($74.50 pp.) is a one unit transistorized keyer with key enclosed in the unit, ac or battery operation, all controls on front panel including speed, monitor tone and volume, semiautomatic or automatic keying, spacing or weight adjustment. Outputs on back include both transistor and relay for operating any type transmitter.



Transkey ($34.95 pp.), electronic keyer and monitor. Relay output, built in key, 5-50 wpm, battery built in or external 6v source, automatic or semiautomatic operation, variable tone monitor, dot-space ratio adjustable, 2 lbs, guaranteed.

- **Global Research & Supplies, Box 271, Lombard IL 60148.**

HAL Devices, Box 365L, Urbana IL 61801.



The all new model 311B IC keyer contains all of the features which make the HAL line the most versatile line of keyers available. Offering triggered time base, iambic operation with dot memory, monitor with tone and volume controls, regulated AC power supply, 150v/500ma transistor switch for both grid block and cathode keyed transmitters, automatic and semi-automatic operation, and tune up switch, the 311B is completely assembled and guaranteed, $43.95 pp. Other models from $15.00.

- Hallicrafters Co., 600 Hicks Road, Rolling Meadows IL 60008.

- Heath Company, Benton Harbor MI 49022.

HD-10 solid state electronic keyer, 15-60 wpm or 10-20 wpm, self completing dashes, semi-automatic if desired, variable dot-space ratio, side tone and speaker, built in ac power supply, use with grid block keying transmitters, $40.

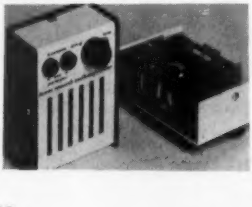
HD-16 code practice oscillator, transistorized, battery operated, with speaker, $10.

- A.T. Hunter, 6201 Jumilla Avenue, Woodland Hills CA 91364.

HDK Digital Keyer, IC built, battery operated, $28.

- Hunter Sales, Inc., Box 1128, Des Moines IA 50311.

- James Research Company, 20 Willits Road, Glen Cove L.I. NY 11542.



Oscillator/monitor, mark 2, price: $14.95 pp. This versatile product for the CW operator and ham experimenter is a super-sensitive rf type of CW monitor, a code practice oscillator, and rf tester, and a non-destructive component continuity and semiconductor tester. It features a 4 transistor 2 diode circuit, a single AA cell for power, and a rugged black and silver anodised aluminum cabinet.

Permaflex Key, price: $19.95 pp. This twin lever key is for use with modern high speed electronic keying circuits. It also converts to a straight hand key for slow speed CW. The independent fibreglass paddles flex to make contact, have adjustable gap and tension, and are fully enclosed in a polished chrome plated cabinet. Contacts and conductors are gold plated for high reliability.

- M & M Electronics, 6835 Sunnybrook NE, Atlanta GA 30328.

RELAY
KEY
DAH-DITTER
MODEL EK-1
SPEED
MODE
TUNE
OPERATE
M&M ELECTRONICS
6835 SUNNYBROOK
ATLANTA, GA

Dah-Ditter model EK-1, electronic keyer to 40 wpm, solid state, self-completing with 3/1 ratio, ac powered, built in monitor, works with present key or bug, $34.95 pp.

- Micro-Z, Box 2426, Rolling Hills CA 90274.

The Pro-Key is an easy-to-assemble kit that provides perfect Morse code from 5 to 50 wpm. When a key is pressed, the character is stored within micro-seconds and cannot be disturbed until complete–permitting you to move on to the next key at your leisure. Completely self contained battery operated, with relay output. Kit includes all parts, pre-assembled keyboard, two printed circuit boards, and detailed, illustrated assembly instructions.

- Palomar Engineers, Box 455, Escondido CA 92025.

IC keyer, all solid state, built in key, fully digital, dot-dash ratio always perfect, keys any circuit up to 100 ma, $67.50. Free brochure.

- Pickering Radio Company, Box 29, Portsmouth RI 02871.

The K-1 Micro-Ultimatic provides dot and dash memories for either conventional or squeeze paddles. 10-60 WPM; internal monitor osc; models for blocked grid or relay output available. One-year warranty, $85.00 FOB.

The ultimate in CW operation. The KB-1 generates any of 47 characters with precision and automatic letter spacing. Press the right buttons; get perfect code. 12-72 wpm; variable weight; internal monitor osc/amp; keys most blocked-grid rigs or external relay. Only 2 x 4 x 10 inches. $265.00 FOB.

- Ten-Tec, Inc., Hwy. 411 E, Sevierville TN 37862.

- The Vibroplex Co., Inc., 833 Broadway, New York NY 10003.

Vibroplex keys, $20.95 to $43.95, including the new Vibrokeyer for use with electronic keyers, $21.00.

- Waters Manufacturing, Wayland MA 01778.

Codax automatic keyer $98.

Microphones & Preamps

- Caringella Electronics, Inc., Box 327, Upland CA 91786.

Model ACP-1 compressor-preamp kit, 30 db range, FET input, PC construction, adjustable input and output, connected for PTT, $18.50.

- Heath Company, Benton Harbor MI 49022.

HD-15 phone patch, hybrid, operates VOX and PTT, $25.

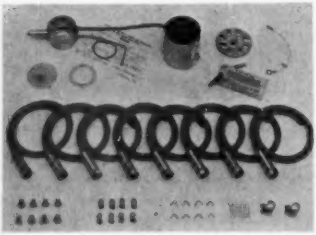
HDP-21 SSB microphone & stand, switch, $29.40

- Waters Manufacturing, Wayland MA 01778.

Hybrid phone patch $55. Patch with Compreamp $76. Compreamp alone $28.

Noise Reduction

- Estes Engineering Co., 543 W 184th St, Gardena CA 90247.



Electro-shield system eliminates ignition noise, custom complete shielding set for any car, $69.95 for eight cylinders, $61.95 for six cylinders. This is the system used for quieting airplanes and is the only way to achieve complete quiet mobile.

Receivers & Converters

- Allied Radio Corp., 100 N Western Ave., Chicago IL 60680.

A-2516 80-10 meter ham band receiver (plus WWV on 10 mhz). Solid state vfo, mechanical i-f filter, preselector, product detector for SSB, crystal oscillator for very low drift, ac operated, $170.

- Ameco, Box 6527, Raleigh NC 27608.

SWL-4 solid state receiver, 540 mhz to 23 mhz in four bands. Model R-5 receiver 540 mhz to 54 mhz in five bands, all solid state with ac supply, $100. R-5 is also available in kit form. Ameco also makes a wide range of converters, solid state and tube, with models for any band.

PV nuvistor preamplifiers for 28, 50, 144, & 220 mhz, also excellent for improving FM two-way equipment, $14.95, each band.

PT preamplifier, covers 6-160 meters, built in power supply, designed to work with SSB transceivers and improve the sensitivity of the receivers, $59.95.

- Collins Radio Co., Cedar Rapids IA.

75S3B receiver, 3.5 to 29.7 mhz amateur bands or any frequency except 5-6.5 mhz in that range with extra crystals, $795.

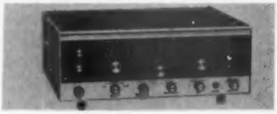
- Drake Manufacturing, Miamisburg OH 45342.

SPR-4 solid state programable receiver. Can be programmed for short wave listening, amateur radio, broadcasting, marine radio, etc. Dual gate FET rf amplifier, 23 500 khz ranges, three bandwidths, high and low freq i-f stages, notch filter, etc. Accessories: noise blanker, calibrator, speaker, loop antenna, transceive adaptor, dc power cord, etc., $379.00. Can handle signals like the best in tube receivers. Extremely stable.

Model 2C receiver, while designed for hamband use primarily, will tune any 500 khz segments from 3-30 mhz. Bandspread calibrated in 1 khz. Selectivity of .4, 2.4, and 4.8 khz, $230. Accessories available: speaker, $20; Q-multiplier/speaker, $40; calibrator, $17.

Model R4B receiver, covers 500 khz segments from 1.5 to 30 mhz. 1 khz calibration. Will transceive with T4XB transmitter. .4, 1.2, 2.4, and 4.8 khz selectivity. Built in noise blanker, calibrator, notch filter, $430.

- Galaxy Electronics, 10 South 34th St., Council Bluffs IA 51501.



R-530 solid state receiver, 0.5 to 30 mhz, 1 khz dial, 50 khz calibrator, noise blanker, $695. Speaker, $40. Receiver has 2.1 khz passband, other crystal lattice filters, $45 for 500 hz, 1500 hz and 6 khz.

- Hallicrafters Co., 600 Hicks Road, Rolling Meadows IL 60008.

SX-122A receiver, 538 khz to 34 mhz, calibrated bandspread of ham bands, $395; accessory speaker and calibrator, $20.

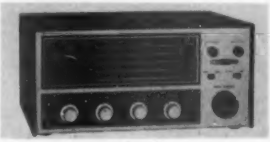
SX-146 ham band receiver, 80-10 meters, accessory calibrator, speaker, and 500 hz filter.

SX-130 general coverage receiver, bc band plus 1.7 to 34 mhz in three bands, accessory speaker.

- The Hammarlund Manufacturing Co., Inc., 73-88 Hammarlund Drive, Mars Hill NC 28754.

HQ-215 solid state receiver, covers 80-15 meter ham bands plus 13 more 200 khz segments from 3.4 to 30.2 mhz. Also covers 28.5-28.7 mhz. 2.1 khz selectivity with supplied filter, $400.

- Heath Company, Benton Harbor MI 49022.

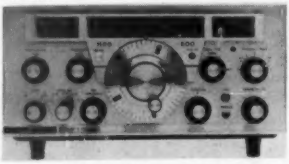


HR-10B receiver, 80-10 meters, ham bands only, $80. Calibrator, $9.

SB-301 amateur band receiver, 1 khz dial, calibrator built in, $260. AM or CW crystal filters, $21. Six or two meter converters, $20.

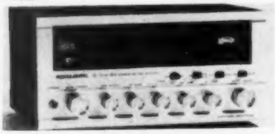
- Lafayette Radio Electronics, Box 10, Syosset, L.I. NY 11791.

● National Radio Company, Inc., 37 Washington St., Melrose MA 02176.



HRO-500 solid state receiver, 5 khz to 30 mhz, 1 khz dial, $1675. Speaker, $40. Tunes in 60 bands of 500 khz each, continuous coverage. 50 khz calibrator built in.

● Radio Shack Corp., 730 Commonwealth Ave., Boston MA 02215.



DX-150 all wave receiver. Tunes dc band, plus three short wave bands to 30 mhz, $120. Matching speaker, $8.

● Herbert Salch & Co., Woodsboro TX 78393.

Pro line converters, crystal controlled single frequencies, any two between 108-175 mhz, squelch, $40 with one crystal, $45 with two. 12v.

SC line converters, single frequency from 26 to 250 mhz, 12v., $25. Weather converter for 162.55 mhz $20. Squelch accessory $18.

X line converters, tunable, 9v., $33. Can be crystal controlled also. Squelch unit $18 extra. Models cover 150-164, 33-48, 118-128, 144-148, 50-54, and 26.9-30 mhz. See ad on page 21, March 1969 issue of 73.

● Vanguard Labs, 196-23 Jamaica Avenue, Hollis,NY 11423.

Model 407 six meter dual gate MOSFET, $35, same for two meters.

3/4 meter converter, three dual gate MOSFETs, $50, 10 meter output. Send for the free catalog of preamplifiers and converters from Vanguard, state of the art in VHF.

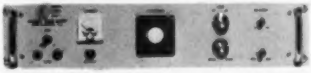
● VHF Associates, Box 22135, Denver CO 80222.

● Westcom Engineering, Box 1504, San Diego CA 92112.

Noise blanket for use with most receivers, transceivers, $29.50

RTTY

● Alltronics-Howard, Box 19, Boston MA 02101.



Teletype equipment, printers perforators, reperforators, polar relays, distributors, accessories, and converters.

● Aquadyne, Box 175, East Falmouth MA 02536.

RTY3 converter, 850/425/175 hz shifts, 3 stage filter, loop supply incl., $140. RTY3SB tuned for use with SSB transceivers, $180. RTY3K, same as RTY3, but built in AFSK generator, $160.

● Essco, 324 Arch Street, Camden NJ 08102.

Solid state RTTY demodulator, single channel, incl. loop supply $132.25, kit. Dual channel unit, kit, $138.25. Factory wired single channel $156.25. Wired dual channel $163.

● Tuck Electronics, 2331 Chestnut Street, Camp Hill PA 17011.

RTTY terminal equipment, solid state, modules, etc.

Surplus

Aerospace Electronics, Box 48-495, Miami FL 33148.

Alvaradio Industries, 3101 Pico Blvd., Santa Monica CA 90405.

Amber Industrial Corp., Box 2129 So. Sta., Newark NJ 07114.

Anker Electronics, 1617 S Main St. & Anker Rd., Wilkes-Barre PA.

ARC Sales, BOx 12, Worthington OH 43085.

Arcturus Electronics, 502 22nd St., Union City NJ 07087.

Arrow Sales Chicago Inc., 2534 S Michigan Avenue, Chicago IL 60616.

Atlantic Surplus Sales, 250 Columbia St., Brooklyn NY 11231.

Barry Electronics Corp., 512 Broadway, New York NY 10012.

B & F Enterprises, Box 44, Hathorne MA 01937.

Bigelow Electronics, Box 71, Bluffton OH 45817.

Brigar Electronics, 10 Alice St., Binghamton NY 13904.

C. & H. Sales Co., 2176 E Colorado St., Pasadena CA 91107.

Columbia Electronics, 4365 W Pico Blvd., Los Angeles CA 90019.

Communication Sales Co., 7231 Hinds Avenue, N. Hollywood CA 91605.

Cornell Electronics, 4205 University Avenue, San Diego CA 92105.

Ted Dames Co., 308 Hickory St., Arlington NJ 07032.

Denson Electronics, Box 85, Rockville CT 06066.

Dow Trading Co., 1829 E Huntington Dr., Duarte CA 91010.

Fair Radio Sales, Box 1105, Lima OH 45802.

Gadgeteers Surplus Electronics, 5300 Vine Street, Cincinnati OH 45217.

Gateway Electronics Corp., 6150-52 Delmar Blvd., St. Louis MO 63112.

G & G Radio, 77B Leonard, New York NY 10013.

J. J. Glass Co., 1624 S Main St., Los Angeles CA 90015.

Goodheart Co., Box 1220, Beverly Hills CA 90213.

Hayden, Box 294, Bay St. Louis MS 39520.

Jan Crystals, 2400 Crystal Drive, Fort Myers FL 33901.

J. & H. Outlet, 476 Industrial Way, San Carlos CA 94070.

Jefftronics Unlimited, 4252 Pearl Road, Cleveland OH 44109.

Jennings, 2730 Chanticleer Ave., Santa Cruz CA 95060.

Jet Crystal Co., 1718 W Lomita Blvd., Lomita CA 90717.

Liberty Electronic, 548 Broadway, New York NY 10012.

Mazer Enterprises, 17740 Bay Circle, Fountain Valley CA 92708.

Mendelson Electronics Co., 516 Linden Avenue, Dayton OH 45403.

Meshna, 19 Allerton St., Lynn MA 01904.

Military Electronics Corp., 4178 Park Avenue, Bronx NY 10456.

Norman Electronics Sales, 1413 Howard Street, Chicago IL 60626.

North American Electronics, Box 878, Plattsburgh NY 12902.

Park Electronics, Box 78, N.Salem NH 03073.

Poly Paks, Box 942A, Lynnfield MA 01942.

Quaker Electronics, Box 215, Humlock Creek PA 18621.

Mike Quinn Electronics, Electronics Bldg., 727 Langley St., Oakland Airport CA 94614.

R & R Electronics, 247 S Meridan St., Indianapolis IN 46225.

Relay Sales, 2400 Crystal Drive, Fort Meyers FL 33901.

Selectronics, 1206 S Napa St., Philadelphia PA 19146.

Slep Electronics Co., Drawer 178, Ellenton FL 33532.

Solid State Sales, Box 74, Somerville MA 02143.

Surplus Specialities, Box 118, Pittsfield MA 01203.

TAB, 56 Pearl St., Brooklyn NY 11201.

United Radio Co., 56 Ferry Street, Newark NJ 07101.

Unity Electronics, 107 Trumbull Street, Elizabeth NJ 07206.

Test Equipment

● Clemens Mfg. Co., 630 S Berry Rd., St. Louis MO 63122.

● Heath Company, Benton Harbor MI 49022.

HM-15 SWR meter, 160-6 meters, 1 kw, 50 or 75 ohms, $15.

HM-10A tunnel dipper, 3-260 mhz, battery operated, $30.

HN-31 Cantenna dummy load, 1.5 to 300 mhz, 50 ohms, 1 kw, $10.

HD-20 100 khz calibrator, to 54 mhz, battery operated, $15.

PM-2 100 khz to 250 mhz rf field strength meter, $13.

● Lampkin Laboratories, Inc., Bradenton FL 33505.

● Omega-T Systems, Inc., 300 Terrace Village, Richardson TX 75080.

● Paxitronix, Inc., Box 1038, Boulder CO 80302.

● Quement Electronics, Box 6000, San Jose CA 95150.

● Radio Shop, 48 Elm St., New Canaan CT 06840.

● Redline Company, Box 431, Jaffrey NH 03452.

Mini-lab, ten test instruments in one, VOM, rf sig gen, af sig gen, resistor and capacity substitution, rf field strength, self powered, $25 pp.

Signal tracer model SE350, signal strength meter, output speaker, rf and af amplifiers, measure gain of any rf or af stage, self powered, $23.50 pp.

Miniature AF signal generator, laboratory grade, ac powered, 10-100,000 hz, $60 pp.

● Spectrum Ltd, 245 Gregg Ct, Los Gatos CA 95030.

390-900 mhz frequency meter, indicates down to 2 microwatts, 500 ua meter, $39.50 pp. With built in 100 ua meter, $1.50 additional.

● Syntelex, 39 Lucille, Dumont NJ 07628.

SDA solid state decade amplifier converts VOM or VTVM into a sensitive audio and i-f milivoltmeter or use as preamp for counter, scope, etc., $35 pp.

● The Technical Materiel Corp., 700 Fenimore Road, Mamaroneck NY 10543.

● Waters Manufacturing, Wayland, MA 01778.

Dummy load wattmeter 1 kw $135. 1500 watt $145. Dummy load $65.

Towers

● Dura Tower Sales, Box 322, Angola IN 46703.

Tilt-up and tilt-over steel towers; tilt up to 50°, and tilt-over to 90°.

● Gateway Towers, 7530 Big Bend Blvd, St. Louis MO 63119. Free standing, crank up, crank up–tilt over, free standing-tilt over, free standing-fold over towers of aluminum.

● Heights Mfg. Co., 4226 Maybury Grand, Detroit MI 48208.

Self-supporting tapered aluminum crank-up and fold-over towers.

● Microflect Towers, 3575 25th Street SE, Salem OR 97302. Light weight aluminum towers to 120 feet high in 10 foot sections. 12-1/2 lbs per section. Staggered ladder treads for easy climbing.

● Rohn, Box 2000, Peoria IL 61601. Largest manufacturer of steel towers. Hot dipped galvanized towers of all kinds: free standing, guyed, tilt over, etc.

● Tri-Ex Towers, 7182 Rasmussen Avenue, Visalia CA 93277. Steel towers. Crank up, self supporting, guyed, rotating.

● Tristao Towers, 415 E 5th Street, Hanford CA 93230. Self supporting and guyed crank up towers of galvanized steel and self supporting crank up mini-masts.

● Universal Manufacturing, 6017 E McNichols, Detroit MI 48234. Free standing aluminum towers. Towers to 90 feet.

● Vesto, 1916 Clay Street, Kansas City MO 64116. Self supporting steel towers.

TV

● ATV Research, 13th & Broadway N, Dakota City NB 68731.

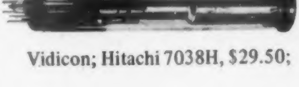
Build it yourself solid state vidicon cameras, accessories, modules, lenses, instructions. Camera kits as low as $117. Video module, $20. Vert. module, $15. Horiz. module, $15. RF osc module, $10. HV module, $10. Free details.

● Denson Electronics, Box 85, Rockville CT 06066.

Used cameras, TV crystals, vidicons, accessories, lenses, gadgets, send for free flyer and be amazed. World's largest collection of TV stuff.

● GBC, 74 Fifth Avenue, New York NY 10011.

Video tape recorders, vidicons, etc.



Vidicon; Hitachi 7038H, $29.50;

Hitachi 7735A, $34.50; Hitachi 7262, $34.50 (replacement for Sony and Panosonic); Hitachi 8507, $74.50 (Separate Mesh).

● Vanguard Labs, 196-23 Jamaica Avenue, Hollis NY 11423

Television camera, complete, great for closed circuit TV, ham TV, $280.

Camera kit, including vidicon and lens, $100.

Transmitters, Transceivers & Linears

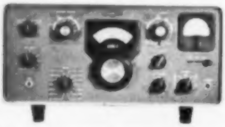
● Aerotron, Inc. (Ameco), Box 6527, Raleigh NC 27608.

AC-1 Novice CW transmitter, 40-80 meters, kit. TX-62, six and two meter phone-CW transmitter, 75W, $160. VFO-621, vfo for use with any VHF transmitter, $70. GSB6, Gonset six meter SSB transceiver, 20 watt PEP. Gonset 903 linear amplifier, two meters, 500 watts PEP. 913 linear amplifier, six meters 500 watts PEP. Communicator IV, six meters, transceiver, 20 watts input.

● Allied Radio Corp., 100 N Western Ave., Chicago IL 60680.

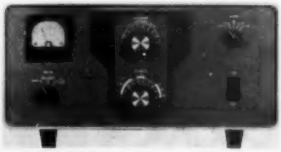
TR-106 six meter transceiver, 15 watts input, $90. V-107 VFO kit, six and two meters, $25. T-175 six or ten meter linear amplifier 330 watts PEP on SSB, 120 watts AM, $100.

● Collins Radio Co., Cedar Rapids IA.



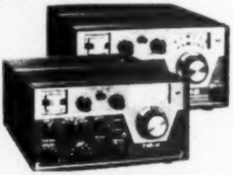
KWM 2 transceiver, 175 watts PEP, 80-10 meters, $1150. AC supply, $153. PTO, wattmeter, patch, speaker, $350. DC supply, $235. Mobile mount, $255.

32S3 transmitter, 175 watts PEP, same range as 75S3 receiver, $865.



30L1 linear amplifier, 1000 watts PEP, 80-10 meters, $520.

● Drake Manufacturing, Miamisburg OH 45342.



TR-4 SSB transceiver, 80-10 meters, 300 watts PEP, solid state vfo calibrator, 1 khz dial, CW sidetone, $600.

TR-6 six meter SSB transceiver, 300 watts PEP, calibrator, $600.

2NT 100 watt CW transmitter, 10-80 meters, $150. L-4B linear amplifier, 2000 watts PEP, 80-10 meters, two 3-500Z tubes, $750.

TR44B, R4B and T4B in one case, $850.

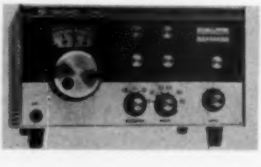
T4XB 200 watt transmitter PEP, 80-10 meters or any 500 khz range between 1.8 and 30 mhz. Covers 160M with accessory crystal, $450.

TC-2 180 watt transmitting two meter converter, $300.

TC-6 six meter transmitting converter, $250.

C4 station console includes clock, timer, patch, wattmeter, rotor control, etc. $300.

● Galaxy Electronics, 10 South 34th St., Council Bluffs IA 51501.



GT-550 SSB transceiver, 550 watts PEP, 80-10 meters, $475. Accessories: RV550 remote vfo, $75; RF550 rf console, $69; SC550 speaker, $25; LA550 linear amplifier 200 watts PEP, $495; PR550 patch, $49; DC supply, $125; AC supply, $90; Calibrator, $25 (25 khz); CW filter, $30; VOX, $30.

● Hafstrom Technical Products, 4616 Santa Fe, San Diego CA 92109.

LK2000, 2000 watt PEP linear, $795. LK2000HD, 3000 watt PEP linear, $895. RF2000, table top rf section only, $595. PS2000 power supply, $300. Heavy duty PS3000 supply, $400. DL2000 dummy load, $75.

● Hallicrafters Co., 600 Hicks Road, Rolling Meadows IL 60008.

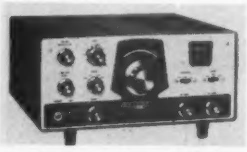
SR400 Cyclone transceiver, 80-10 meters, 400 watts PEP, $800. AC supply PS500A-AC, $130. P500DC supply, $160.

SR2000 Hurricane transceiver, 80-10 meters, 2000 watts PEP, $1095. P2000 AC supply, $450.

HA20 VFO/VSWR console for 400 or 2000, $200.

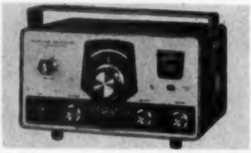
● The Hammarlund Manufacturing Co., Inc., 73-88 Hammarlund Drive, Mars Hill NC 28754.

● Heath Company, Benton Harbor MI 49022.



HW-100, 80-10M transceiver (SSB), 180 watts, $240. Speaker, $19. DC supply, $65. AC supply, $50.

HW-12A, 80M SSB transceiver, 200 watts PEP, $100. HW-22A, 40M transceiver, $105. HW-32A,



20M transceiver, $105. Calibrator, $9. Microphone, $8.50. DC and ac supplies same as above.

HW-17 2M AM transceiver, 25 watts input, $130. DC supply, $25.

DX-60B transmitter, 90 watts, 80-10 meters, phone or CW, $80.

HG-10B VFO for use with DX-60, HW-16, etc., 80 thru 2M calibration, output 3.5-4, 7-7.425, and 8-9 mhz ranges, $40.

HW-16 CW transceiver, covers first 250 khz of 80-40-15 meters (Novice), 75 watts input, $110.

HW-29 six meter transceiver, AM, 5 watts, crystal controlled, super regen receiver, $45. HW-30, same, only for two meters. Mobile power supply, $18.

SB-500, two meter transmitting converter for SSB, used with existing 6 or 10 meter SSB transceiver, 140 watts PEP, $180.

SB-401 SSB transceiver, 80-10 meters, 180 watts PEP, 1 khz dial, will work with Heath SB-301 receiver, built in power supply, $285.

SB-200 matching linear amplifier, 1200 watts PEP, built in power supply, $220.

SB-110A, six meter SSB transceiver, 180 watts PEP, $299.

SB-101, 80-10 meters, 180 watts PEP, SSB transceiver, 1 khz dial, WCW sidetone, $370.

SB-630 station console, digital clock, swr meter, patch, timer, etc., $75.

- Henry Radio Stores, 11240 W Olympic, Los Angeles CA 90064.

2K-3 linear amplifier, 80-10 meters, 2000 watts PEP (plus), $745, complete with power supply. Can be driven with most SSB transceivers.

3K linear amplifier, 80-10 meters, continuous 1 kw input duty (or more) for RTTY, etc., $895. Power supply built in. Either linear available in console or desk models.

- Hunter Sales, Inc., Box 1128, Des Moines IA 50311.

Bandit 2000C, linear amplifier, five bands, kit form, 2000 watts PEP

- Lafayette Radio Electronics, Box 10, Syosset, L.I. NY 11791.

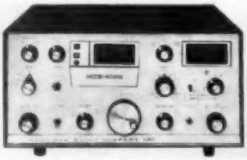
- Linear Systems, Inc., 220 Airport Blvd., Watsonville CA 95076.

SB-34 SSB transceiver, 80-15 meters, $450. SB2-LA linear amplifier, $260. SB3-DCP, dc power inverter for mobile operation (SB-34 has ac power supply built in and is solid state except for power stages).

VOX unit, $38. 25 khz calibrator, $29. Microphone, $15.

• National Radio Company, Inc., 37 Washington St., Melrose MA 02176.

NCX-500, 80-10 meter SSB transceiver, 500 watts PEP, $425. AC power supply, $99. AC supply/speaker console, $110. 100 khz calibrator, $26.60.

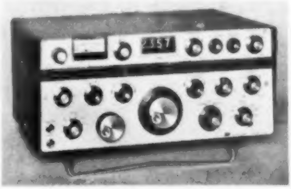


NCX-1000, 80-10 meter SSB transceiver, 1000 watts PEP, all solid state except power stages, $995.

NCL-2000 linear amplifier, $685, complete with power supply.

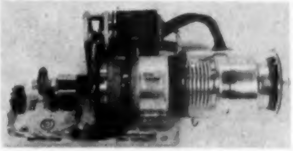
• RF Communications, Inc., 1680 University Avenue, Rochester NY 14610.

• Signal One, 2200 Anvil St. N, St. Petersburg FL 33710



CX7 deluxe integrated station, solid state, 10-160 meters, 100 hz frequency readout, dual VFO's, ac supply built in, 300 watts, noise blanker, etc., $1600 (or more).

• Slep Electronics, 2412 Highway 301N, Ellenton FL 33532.



Jennings variable capacitors for linears, 10-300 pf 7500v, $32.50 pp. complete with gear drive train, mounting bracket.

• Spectronics, Box 356, Los Alamitos CA 90720.

FTDX400 transceiver, 25 khz calibrator, 80-10 meters, 500 watts PEP, sidetone, offset tuning, $600. Speaker $15.

FTDX2000 linear amplifier, 1200 watts PEP, SWR bridge built in, solid state power supply, $250.

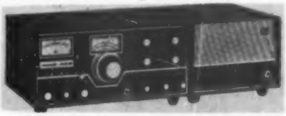
FVDX400 vfo for use with transceiver for split frequency operation, $100.

• Swan Electronics Corp., 417 Via Del Monte, Oceanside CA.

260 Cygnet 260 watts SSB transceiver, built in ac/dc supply and speaker. 80-20-15-10 meters, $435.

270 Deluxe Cygnet 80-10 meters, $525. 508 external vfo, $125. Linear amplifier, including ac power supply, 1200 watts, for 270 and 260, $295.

500C SSB transceiver, 80-10 meters, 520 watts PEP, $520. AC supply with speaker, $105. DC supply, $130. Phone patch, $28.



350C transceiver, similar to 500C except no calibrator, sideband switching, ANL, etc., $420.

250 six meter SSB transceiver, 240 watts, $420.

Mark II Linear amplifier, 2000 watts PEP, $395. Power supply, $235.

• VHF Associates, Box 22135, Denver, CO 80222.

STICKY RELAY CONTACTS

I bought a new Dow-Key antenna relay for my Heath Seneca VHF-1 transmitter, and experienced a problem with the relay contacts sticking when the function switch was returned to the stand-by position. The trouble was that the Seneca was emitting a signal before the antenna relay contacts had closed and thus the contacts arced and welded together.

The problem was solved by utilizing the "Remote Control" terminals on the octal socket on the back panel of the Seneca. I just wired these contacts into the external contacts on the antenna relay so that the remote control terminals were shorted only after the relay had closed, thus preventing the Seneca from transmitting before the relay had closed. No futher trouble was experienced with sticking antenna relay contacts.

This same trick may be used with any transmitter using a relay for antenna switching, as long as the antenna relay has two normally open contacts. If the transmitter does not have several contacts that must be closed before the transmitter will transmit, the keying terminals may be used in the same manner; just make sure that the keying terminals must be shorted before the transmitter will transmit, and then wire the terminals into the antenna relay's external contacts.

Steve Harrison WB6PKA

SEXtupler Corrections

Page 62, November, 1969, Fig. 4. The filament transformer primary should connect between the filament switch and the hv switch and should not be black-dotted to short out the line. The left side of the time delay switch should not be black-dotted to the lower line. As shown the circuit is more of an acme fuse tester than a SEXtupler.

PICKERING RADIO CO
Post Office Box 29-A
Portsmouth RI 02871

NOW! USE YOUR TAPE RECORDER TO LEARN CODE!

Read code like a Pro! It's easy! PICKERING CODEMASTER tapes give *professional instruction* on your own tape machine from digital computerized tapes! They can't be matched for timing accuracy! Beginners get course of professional instruction at 5-9 WPM right on the tape! Practice for General and Amateur Extra ranges from 11 to 30 WPM. Nothing else like it! See below for CODEMASTER tapes you need. Get up to speed! Order today!

CM-1: For the beginner. A complete course of instruction is on the tape. Practice material at 5, 7, 9 WPM. Prepares you for Novice exam. Includes code groups and punctuation.

CM-1½: An intermediate tape, especially for General Class exam study. No instruction; just practice. ½ hr 11 WPM; 1 hr 14 WPM; ½ hr at 17 WPM. Includes coded groups and straight text.

CM-2: For Extra-Class license study. Mostly straight text; some code groups. 1 hour at 20 WPM; ½ hour each at 25 and 30 WPM. For real QRQ, play this tape at twice speed!

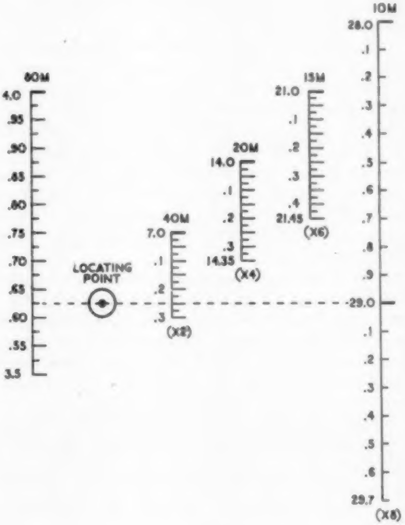
CODEMASTER tapes are 2-track monaural; available in two sizes: 7-inch reel (3¾ IPS) and 3¼-inch reel (1⅞ IPS). Will play on any but full-track machine. **SPECIFY both type and size of tape you want.** Any tape, $5.95 postpaid USA 4th class. Any two tapes, $11.00: all three, $15.00 PPD. Immediate delivery. CODEMASTER tapes are made only by Pickering Radio Company, P.O. Box 29-A, Portsmouth, R. I. 02871. Satisfaction guaranteed.

Low-Band Nomograph

How many times have you picked up a 40 meter crystal and wondered whether or not it was usable on 10 meters? Or, how about the times you wanted to check for spurious radiations on other bands when you were on 80 meters? In such cases, you got out the pencil and paper and started multiplying the crystal frequency by different multipliers until you arrived at the answer you were looking for.

Well, here is a nomograph which takes a considerable amount of the figuring out of it. By laying a straightedge from your 80 meter crystal frequency through the locating point, you can tell at a glance whether the same crystal is usable on another band. At the bottom of each band, the correct multiplier, with reference to the 80 meter crystal frequency, is also shown.

Additionally you can check whether or not a crystal is usable on a higher frequency band by laying a straightedge through the frequency and the locating point. If the multiplier of the lower band is an integer and not a fraction, then it is usable and a glance will show the approximate frequency.



The dotted line shown on the nomograph serves as an example. An 80 meter crystal marked 3.625 mhz will produce harmonics on both 40 meters and 10 meters at approximately 7.25 mhz and 29.0 mhz respectively. Additionally, of course, it shows that by using a quadrupler and doubler or three doubler stages (X8), you could use the 80 meter crystal on 10 meters. One step further says that if you had a 40 meter crystal marked 7.25 mhz, a quadrupler stage or two doubler stages would provide a 10 meter frequency at 29.0 mhz. The (X8) multiplier divided by the (X2) multiplier gives the required multiplication of (X4).

So replace that pad and pencil with a straightedge for those quick answers when you don't need to know a precise number. Think of the time for rag-chewing you might pick up. . . . **E. R. Davisson K9VXL**

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters have been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

(continued from page 4)

Contest buffs detest net personnel. Phone operators constantly denigrate CW practitioners. RTTY fans demean phone patchers. VHF men have contempt for low band operators. AM boys are revolted by SSB'ers. Designers and constructors hate "appliance operators." Technicians distrust all higher grade licensees. Old timers resent "Johnny-come-latelies." Youth maligns age. And so forth, and so on, ad infinitum.

Is it any wonder that in the world at large, where the divisions are even more marked, there are irreducible tensions and schisms? Is it so strange that human society suffers constantly from the syndromes of fear, distrust and hatred, since the stakes are so much higher . . . life or death; destruction or survival. The microcosm reflects the macrocosm, does it not?

Whatever your persuasion, or even if you have none at all, one thing you must grant. It took a Roman Catholic Prelate to make the most meaningful attempt, to date, to overcome this universal problem. Pope John XXIII was the one individual who actually formulated a viable modus operandi, through which some progress might eventually be made. I am speaking of Ecumenism. This is the key to everything. This is the foundation stone upon which an indestructible bastion of unity may finally be built.

This is true of differing faiths and nations. And it is no less true of all sorts of contending factions, no matter how small, no matter how trifling in the larger scheme of things. The spirit of Ecumenism, if applied to situations where contentiousness and angry confrontation exist, may overcome all these problems, when all else has fallen short.

Well, how about us? How about the constant intra-mural tensions in ham radio? Are they piddling little differences of no concern? Are they unimportant trifles which do us no injury? Are they mere annoyances, to be tolerated with a shrug of insouciant resignation? Shall we continue to say, "That's the way of the world. That's human nature, and you'll never change it"?

In my judgment is is still not too late. I believe that these differences are still too small and unimportant to outweigh the positive areas in which we all see eye to eye. But the world is changing fast, and extreme positions are polarizing rapidly toward even wider and more unbridgeable gulfs. I feel deeply that all of us must seek the means by which to build a mighty sense of solidarity throughout our entire fraternity. I think that if we do not do this, that if we fail to understand that there are strong exterior forces, bent on compromising or destroying our privilege, we may find ourselves becoming witnesses to the death agonies of Amateur Radio as we know it, and as we would like to see it remain.

Let's not forget that great slogan of the early American colonists, "United we stand . . . Divided we fall."

* * *

I've just written a letter to FCC Chairman Nicholas Johnson, concerning a recent appearance on network television, in which he made some allegations with which I totally disagree. I took the additional opportunity, since I was also disturbed over other matters with respect to Amateur Radio, to give voice to some opinions shared by many of you. While there are those who will feel that any individual expression of ideas to the FCC would tend to be inimical to the cause of our hobby, in my view there has been ample precedent for this. When ARRL communicated with FCC in this self-same manner, urging the adoption of Incentive Licensing, it was clearly an exercise of this type of unilateral contact. Yet, I do not seem to recall any prior discussion in the pages of QST with respect to the forthcoming changes that the League was about to propose. The discussion occurred afterwards . . . and how! On the air, in magazines like this one, in private conversation . . . yes! There was surely plenty of discussion; but not in QST. There, excepting for a few letters from dissident and clearly benighted ignoramouses, all such discussion was conspicuous by its utter absence.

About my letter to Johnson itself; there isn't anything in it that has not appeared in these monthly journals of mine. I told the Chairman exactly how I and tens of thousands of licensees feel about the past year of re-structure. I told him what I and the others think of the second phase, and what it will mean in terms of our good and welfare. This, despite objections from those who feel differently, is not "making waves." It is merely an exercise of that peculiarly unique American birthright, good old Freedom of Speech.

The most important thing; I urged him to see to it that FCC hold public hearings, *whenever* any changes in structuring are contemplated. If ever the Commission should decide to consider *any* change in *any* area of the licensing structure, there should be as wide and open a discussion as possible, with all interested and concerned parties participating; not merely one group which alleges that it speaks for everybody.

I cannot see any possible objection to such public hearings. At least, all views would be heard, and a fair, objective, impartial body of fact would emerge, thus enabling the Commission to deliberate in a much more intelligent and representative fashion.

* * *

More people are complaining about TV commercials these days. This is one of the fastest growing topics of discussion on the bands. Since my business is writing a sort of doggerel, I've decided to register my comments in the disreputable and rather gauche manner of my craft. I will not, however, set it to music. I write *good* songs.

Ode to TV

Banal, revolting nauseating box,
A plague, a pest, foul pestilence, a pox,
A smell, a stench, an odor rank and ripe,
Dull, crashing bore, insufferable tripe.

TV brings you high adventure,

Squirt your armpits, soak your denture.
Win a mate who'll share your pillow,
Use SOS instead of Brillo.
Revlon for your fingernails
Enden for your dandruff scales
Maybelline for longer lashes
Unguentine for sunburn rashes
Roto Rooter for a flood
Geritol for tired blood
Kraft for all your midnight snacks
Dingy floors? Use Johnson's wax.
Solid state by Motorola
Liquid state by Pepsi Cola
Wonder Bread to make kids thrive
Groom your hair with VO Five
Switch to this brand, Change to that,
Smoke a thin smoke, smoke a fat.
All up and down the whole damned map
The air is filled with solid crap!

This shallow, vapid, rank inanity
Must deal destruction to our sanity.
I state with validity and lucidity
To hell with audio-video stupidity.

* * *

Almost every foreign amateur radio society provides an outgoing QSL service. I would be the very last to critize the work that QSL bureaus are doing. It is a thankless job, tedious and monotonous. But only half the job is being done.

It seems incredible that ARRL consistently refuses to consider the establishment of an outgoing service, so that our cards might be sent out at a saving of many dollars. The cost of QSL'ing is becoming prohibitive to the average man, who has to work for a living. It is going to rise even higher, according to indications. Postage rates are going to rise again, and it is ridiculous not to avail ourselves of the economy that this type of service could provide.

I suggest that those who find this idea meritorious should write their Directors and ask for his position on the question. Perhaps, if enough hams write and ask about it, there will be more than an ambiguous platitude for an answer.

* * *

There's a little story about a rather crusty, frontier-type United States Senator, who was invited to a very posh Embassy banquet in Washington. The soup was served, and it was scalding hot. The Senator took one spoonful of it, and it burned his tongue so badly that he spit it out, all over the rather amply endowed bosom of his dinner partner, who was the wife of some foreign ambassador. There was stunned silence, and an air of shocked disbelief at his faux pas.

The Senator was non-plussed for only a brief moment. Then he looked around the room and said, "You know, I'll bet some damned fool would've swallowed that stuff."

Well, friends, some damned fools'll swallow just about anything!

Take, for example, some of the letters that crop up in the correspondence section of a certain

COLUMBIA
SPACE RACE
(We have to get rid of these items now—'cause we gotta have the space!)

TAMAR 12V. MOBILE RF POWER AMPLIFIER
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periodical. These indicate that the writers have been brainwashed into a belief that anything which emanates from the Newington "fountainhead' must be true, beyond peradventure. There seems to be a precept; an axiom, if you like, amounting almost to an article of faith, that if anything concerning ham radio is published by the League, then it's just got to be so.

The tone of some of these letters is so insufferably pious as to make the gorge rise. These goody-goody boys, fired with all the zeal of a holy crusade, make me want to vomit!

Here are a few examples from recent issues of QST. I need not make too probing an examination of them, for they are fairly transparent. Besides, why denounce them? They're not worth it. We all know about sow's ears and silk purses.

". . .incentive licensing is good for. . .national preparedness."

Outside of statements to this effect in QST, I cannot find a single piece of evidence to support any contention that anyone in the Defense Department or any other Department of the Government said it.

". . .reawakened my interest in learning more theory, particularly solid-state techniques."

Very interesting. So how come the Extra Class exam has no more about solid state than it did five years ago?

". . .I'm now ready to apply for another DXCC endorsement."

A total non-sequitur. 90% or more of the avid DX'ers are in the general class. And no single group has been more opposed to Incentive Licensing that the generals. And, incidentally, no other group has lost more frequencies.

". . .recent polls *taken by the League* (my emphasis) concerning policies indicate our League . . .is tapping the members for new ideas."

This is certainly news to every ARRL member. Where in the world has this guy been? Or out of the world?

". . .believed for years that strength in amateur radio is the quality and not the quantity of operaters."

So who's claiming that Elements 4A and 4B will transform lousy operators into good ones? This is arrant nonsense, and I can't believe that even the fellow who wrote it, actually believes it.

". . .I consider the League to be the most important and most influential driving force in amateur radio today."

True. But how much better it would be if it were also the most democratic and representative force as well, instead of a complacent, self-satisfied, unresponsive one.

". . .the majority are behind and beside you.' Evidently he means the majority of Directors, SCM's, and other League appointees, none of whom ever seem to have any differences of opinion with the official line. The same writer states further. . .

". . .minority which invokes to force its will . . .by their own selfish, self-righteousness and narrow-mindedness they will destroy."

A clear case of the pot calling the kettle black. The only minority forcing their will in this fashion is the entrenched minority in Newington. The membership, not the leadership, is the majority. And the total League membership is but a minority within the total ham population.

". . .I think the number of Extra Class operators will increase greatly after November 1969.'

If FCC believed this canard, why did they finally rescind the Phase Two CW provisions wholly? The FCC examined Phase One in retrospect, and found nothing to indicate that further implementation as originally projected, for CW, at any rate, would accomplish the expected results. This idea stated by the correspondent was based solely upon the wishful thinking of the original proponents of re-structing. How egotistical to refuse to allow for the possibility that they might have been wrong in the first place.

Well, folks, as I said in the beginning, some damned fools'll swallow just about anything! Nicht wahr?

* * *

In November of 1963, when President John Kennedy was assassinated in Dallas, a tremendous hue and cry went up to illegalize firearms. Despite the furor and the public clamor for action, the final upshot was that no effectual legislation was enacted. Why?

Later, when Rev. Martin Luther King, Jr., and Senator Robert Kennedy were gunned down, similar demands, ever more insistent, were made. Again the movement toward firearms control was circumvented. Why?

Every single time a program of anti-gun laws is instituted, it is anticipated, met, and foiled. Why is this always the case? And how does it come about?

The answer is no mystery. One force, dedicated to one purpose, has withstood all these attacks for many years. The National Rifle Association has stood between these public onslaughts and the Second Amendment to our Constitution, part of our Bill of Rights, which guarantees the citizens' right to bear arms!

Well, how is the NRA able to accomplish this Herculean mission? It does so through the so-called "gun-lobby." What is a gun-lobby? It is a combination of forces, within and outside of the NRA, which, by many methods, constantly works in the interests of the gun sport group in all possible areas.

It supports a large effective information center, which publishes and distributes educational material, legislative bulletins, news letters and other printed matter. It works in conjunction with state fish and game authorities, training youth in safe gun handling, and authorizing the issuance of hunting licenses. This has alone created good public relations, because it has cut down gun accidents tremendously. It engages in legislative propaganda among members of the Congress. It issues press releases which acquaint the public with the positive side of gun sports. It keeps in constant touch with the gun owners, hunters and collectors, urging them to write to their representatives in the Senate and the Congress. In short, it does a job of public relations which has been eminently successful in protecting the interests of this particular group of American citizens.

You can go down the line. Hundreds of organized groups have maintained their security from unwarranted attack (and sometimes warranted attack) by means of this method. Medicine, manufacture, finance, press, radio and TV, agriculture, shipping, veterans, mental health groups, fraternal organizations, religious groups, trade unions. . .and countless others.

And what is Amateur Radio doing while this is going on? I'll tell you what Amateur Radio is being told to do. It is being advised to volunteer for the Kiwanis club luncheon, to put on a hobby show for the local PTA, to write a little story for the business house organ, to deliver a message to a serviceman's mother and then tell the local press about it, etc., etc.

When is the League going to wake up? When is it going to realize the fact that we need to get into the water in order to swim?

Thousands of dollars are being accumulated by the League, yet it refuses to spend any of it in the interests of Amateur Radio. We could be doing a splendid job of public relations in Washington, D.C., where it would really count; among the lawmakers of this Nation. We could be accomplishing more good for ourselves and our hobby in one month that in the ways suggested by the League in twenty years!

Well, what's the objection to establishing such a program? Only this; that we might jeopardize our tax-free status. Can you imagine it? The main reason we are not doing this is for the sake of saving more money; taxes, in fact! What is the League intending to do with the money it amasses thus? Goodness knows. I don't!

It is freely admitted that we must have a good public image. I quote from a recent issue of QST. . .

> "Good public relations are important to nearly every society, corporation or charity, but especially important to us–our very licenses depend upon our activities being in the public interest, convenience or necessity. We must leave no doubt in the minds of the public that we fill this requirement to overflowing."

Very nicely put, Mr. H. Now, how about the League putting its money where its mouth is?

Case rests!

* * *

POEM

Murphy saw the tube turn blue,
Said, "I know just what to do,
Disconnect the braided strap
From the final's anode cap.
Pull the tube out, gently rock it,
Put a fresh one in the socket.
Peak the grid and dip the plate,
Dive right in, don't hesitate."

Murphy said, "There's nothing to it."
Then he set about to do it.
Stuck a folded-up match box
In each of the interlocks.
Grabbed the tube that had been gassy
Didn't ground it to the chassis.
Plus. . .he left the AC wire
Plugged into his rectifier.

Thunder, cannons, rockets, guns,
Stars and comets, moons and suns,
That's what Murphy heard and saw
When he disputed Murphy's law.
R. I. P.

. . . Dave Mann K2AGZ

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6-9.1 Mc.	BC-455	$14.95	$17.95	$21.50
1.5-3 Mc.	R-25	—	$19.50	$21.50
TRANSMITTERS.	Complete with Tubes			
4-5.3 Mc.	BC-457	$ 6.95	$ 8.95	$11.95
5.3-7 Mc.	BC-458	$ 6.95	$ 8.95	$12.95
7-9.1 Mc.	BC-459	$17.95	$19.50	$23.50
2.1-3 Mc.	T-18	—	$ 9.95	$11.95
3-4 Mc.	T-19	—	$12.50	$16.95

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(continued from page 2)

the rarer countries and would like to thank the operator for helping to make amateur radio more fun for you. In addition to cards, you might take a look around your cellar, attic, workshop, garage, barn, or whatever and see what radio equipment or test equipment you have stuck away that you can manage to do without. A lot of this stuff is too much trouble to turn into cash or really not worth all that much for trading, and could use a good home. This gear, which is just junking up your place, is needed desperately in dozens of countries and can help the cause of amateur radio incalculably if you will take the time and trouble to get it where it is needed.

How do you find out where to send equipment? Well, if you are active on any of the DX bands all you have to do is ask any of the ops you contact just about anywhere in Africa, Asia, the Pacific area, and any other remote island or country. I doubt if you will find one of them that does not know a number of fellows who would like to be on the air, but cannot possibly afford to buy the equipment.

If you are not a DX'er, then you can pick up a copy of the foreign edition of the Callbook and find most of the amateur radio societies of the world listed there. Just drop them a letter explaining what you have in mind. I think you will find them cooperative beyond your expectation. Pages 116-117 of the 73 DX Handbook list foreign amateur radio societies.

The DX operator will explain how to ship the equipment (and parts). In many cases it is best to ship the equipment with the tubes and perhaps the power transformer removed, sending it as inoperative used equipment. The tubes can go later as used tubes. They may not need the transformer since their power is probably 220 volts, or worse.

There may possibly be a country in Africa, the Middle East, the Far East (except Japan), or the Pacific where amateur equipment is not in great need, but I doubt it.

New Year's Resolutions

Trite, I admit, but still a worthwhile concept. 1970 is a new year, and we all have a good chance to be better people this next year. Perhaps we can do a little better at keeping our cool when there is a pileup. Maybe we can sit back and listen a little more while others are falling apart jamming the channel with wasted rf. Perhaps we can try a little harder to maintain our dignity when attacked or annoyed by some idiot or rascal that is using his amateur radio license as a means for airing his psychological problems. One of the main marks of maturity is not seriousness, but the ability to not be *forced* to react emotionally when provoked. Can someone *make* you mad? There is a world of difference, psychologically, between getting mad at someone because it is the best and appropriate response to his actions, and getting mad at him because you can't help yourself. In one case you are in control of yourself, and in the other *he* is in control of you. The mature individual is a self-determined person, not one driven by the emotions of others. The mature person is freely emotional, not just closed down like the schizophrenic.

In practice this means accepting the immaturity of others with good spirits. When the QSO is interrupted by a break-break-break, you acknowledge the chap, but explain to him that you wish that he wouldn't do that. . . that he wait until a contact is completed unless he has urgent traffic. When you hear something on the air that makes you mad, hold that switch. . .try and reason *why* this is bugging you. No matter how terrible the provocation, your angry response just can't help matters.

Many operators, particularly the newer ones, are thoughtless and inconsiderate. Children are this way too, and the cure is education. Unless the op is in the throws of a serious mental breakdown, he will learn if given the information in a friendly way.

The most serious mental illness of the aged is said to be self-righteousness. Try not to age before your time and help people as friends rather than being overbearing or inclined to lecture.

CW vs RTTY

The results of the Armed Forces Day code and RTTY copying contests are interesting. 466 copied the CW message and 424 copied the RTTY message! Perhaps that tells us something about the direction that things are going. By next year the RTTY'ers may outnumber the CW ops.

Where Are They Now?

Way back in 1942, while getting my radio fundamentals at the Radio Materiel School on Treasure Island, I ran across a bunch of ham call letters listed on a bench in building 9B. For some reason I copied them down, thereby preserving them for posterity. Does anyone know where these fellows are these days? In 1942 they were among the tens of thousands of amateurs who turned their hobby into a valuable asset for their country.

W9LSX
W8CXY
W7FOP
W6FUK
W3HZM
W9AUQ
W5GYK
W7EWM
W6ECB
W1MWY
W9XER
W4HVR
W9OCX
W3HYL
W6UKE
W6LLS
W7FHM
W6EQS
W4EXG
W8TWT
W5ATC
W9YAL
W2JDT
W3IXD
W6SJB
W9KKA
W9GED
W5IRR
W7HSL
W6ERM
W6ECB
W7IZL
W9KLR
W6QEH
W1MOL
W1KQF
W8RVX
W3FGA
W4BAD
W7HAD
W7GOF
W9AOP
W7EXB
W1MA
W5IIA
W9CSE

Improving the Station

In my travels around and my contacts on the air I am surprised at how many amateurs are making do with a lot less equipment than they could be using. Sure, you can make contacts with inexpensive unstable gear, running low power and a poor antenna, but the contacts are a lot better and more fun if you have a beam up there and are running at least medium power. You don't have to have a twelve element beam up on a $10,000 rotating pole to have a substantial signal around the world, just a plain three element single band beam or a quad up thirty feet or so. For well under $250 you can have a nice crank-up tower, beam and rotator, so expense isn't a real excuse for most of us.

When you operate from the more remote spots in the world you begin to appreciate the value of a good signal. The ops in Afghanistan can hear the loud signals just about every night. The medium strength signals come through several times a month. The low power boys are heard a few times a year. It doesn't take much time from a location like that before you begin to look at the matter of power from a much more practical viewpoint.

. . . Wayne

Buy or Rent?

If you have a job to be done around the house and do not have the proper tools or equipment, you can find many shops that make a practice of renting everything from simple hand tools to complex machinery. The radio amateur who wants to make a one-time test requiring an expensive piece of test equipment has no such opportunity. If he works at a place using the desired equipment, sometimes he can arrange to borrow it. Usually, though, he has to buy a seldom-used item, which sits idle thereafter, perhaps never to be used again.

Why hasn't somebody established a business of renting electronic test equipment? A good question. . .and one that has been answered. LeasaMetric has issued a catalog listing hundreds of items of test equipment that may be rented at reasonable monthly rates. The company has branches in many cities (I counted 33) in all sections of the nation. No amateur should be too far from one.

This leasing or renting service should solve many problems for the serious experimenter. For instance, suspose you want to test a new SSB transmitter you've built. The only way an SSB transmitter can be tested so as to show its behavior under the transients of speech is with a spectrum analyzer having a speedy scan rate. Unfortunately, the least expensive model of such a device costs about five times as much as the most expensive SSB transmitter on the amateur market. The solution is to rent one.

Interested? Contact LeasaMetric, 4580 East 50th Street, Tulsa, OK. 74153.

. . .Carl C. Drumeller, W5JJ

TACHOMETER KITS

We bought a large quantity of tachometer meter movement and dials as shown, and while we were wondering how to sell them, one of our customers showed us some ingenious tachometers he developed, using this meter movement. We bought the designs and are offering them to you as kits of electrical parts only, which we are selling at far below the price of the meter alone.

Kit 1. Tachometer & dwell meter, operates from distributor of 4, 6 & 8 cylinder engines. Transistorized . . . . TK1 $5.00 ppd.

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Kit 3. Photo electric tachometer. This is very ingenious. Point the pickup head at propeller of model airplane, or other rotating parts & meter registers rpm by measuring frequencies of interrupted light . . . . TK3 $12.50 ppd.

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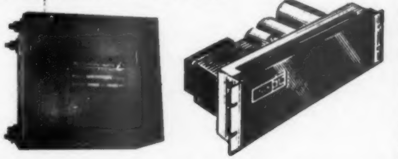

Left illustration – Technipower 20-24 volt 3.0 ampere variable supply. Size approx. 6½" x 7½" x 5". Removed from new equipment. Last price $180.00 Tech P.S. 1 $27.50

Same spec's as above except 6.0 amperes. Size approx. 8" x 9" x 6" . . . . Tech P.S. 2 $47.50

Right illustration – Solar constant voltage regulated supply 15 volts 15 amperes unused, but may have slight rust spots which will not impair electrical performanceSCVPS15

SCVPS $37.50

Same spec's but 15 volts 10 amperes & 5 volts 15 amperes out putsSCVP

Not illustrated . . . Atels controls 12 volts @ 50 amperes and -52 volt 10 amperes variable ±15%. Size 18" x 7½" x 10", about 75 lbs, with buss bar connections on one end. Only four available . . . . .ACPS $60.00

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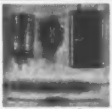

Buy these brand new tantalum capacitors for less than the price of equivalent aluminum foil units, & get high reliability, infinite life, small size, & high temperature performance in the bargain. The regular price of these units is from 10 to 20 times our low price.

Left	25 mfd @ 180 volts	$1.75 ppd
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Center	3.9 mfd @ 75 volts feed thru	3/$1.00 ppd
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Right	1000 mfd @ 50 volts	$3.00 ppd
Middle	26.5 mfd @ 30 volts, non polar	$1.00 ppd
Middle	2 mfd @ 100 volts	3/$1.00 ppd
Bottom	1 mfd @ 75 volts	4/$1.00 ppd

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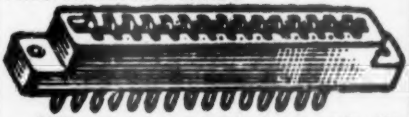

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LETTERS

Dear Wayne:

I just recently bought 30 back issues of your mag. (I'm fourteen and that is the kind of term we use.) I've been reading them day and night and I've just about blown my mind on page after page of technical and constructional articles. But I'm hooked!

Mark Salisbury WA2EWK
Kitchell Road
Convent Station, NJ 07961

Dear Wayne,

There are some pretty good possibilities for amateur talents in Radio Astronomy. Presently, there are about fifty or so individuals who have banded together and formed the Society for Amateur Radio Astronomers. The address is: Society for Amateur Radio Astronomy, Flat 5, 68 Derby Road, Heaton Moor, Stockport, Chesire, SK4 4NF, England. The annual membership dues are $3.50 and include *Radio Sky*, the society journal. But I have an idea that although they may make use of amateur techniques, that they are not licensed amateurs and consequently, not very knowledgeable.

I put together and operated an interferometer at 137 mhz a couple of years ago in Illinois, but due to space limitations I haven't been able to do anything like that here in Michigan. But I know I could certainly put together a small dish. . .or stacked beams as one-half of a phone-linked or radio-linked interferometer pair. (With amateurs doing Moon Bounce at VHF and UHF, they could certainly do a good job at Radio Astronomy.)

I think the idea of aperature synthesis is particularly interesting.

Albert G. Krieger W8BXV
1063 Cranbrook Drive
Jackson MI 49201

Dear 73,

K1CLL's article in the September proves once again that 73 is the most progressive HAM publication. Bill's theories are interesting and would explain several confusing problems presently facing physicists but are open to question at several points. The slowing down of a vortex wave without a decrease in flux density ("increase in volume") is probably impossible. "Friction" would not be responsible because individual photons have never been affected by any other wind. If the slow down is the result of photons losing energy without expanding, the photon mass would be inversely proportional to velocity–this is impossible. If the slow down is the result of energy soakup, the photons would be more energetic but still confined to the same volume; this violates the entropy law.

K1CLL also confuses the role of Fourier analysis in his super-short pulses. When information is broken down to N components and transmitted on N channels simultaneously the waveshape is unimportant. Instead of denying that short pulse-X can be analyzed (which it can), it should be said that any amplitude modulation present carries no information; only the aggregate effect of the various frequencies is meaningful. Actually, Fourier analysis takes amplitude vs. time waves and converts them to a specific set of periodic waves which are pure carriers of varying intensity.

John T. Nogatch WA2FDR/6
California Institute of Technology
Pasadena CA 91109

Dear Youth Editor,

You started your Sept. letter by saying youth is speaking out all over the world. I wonder if this is the reason for all the unrest throughout the world now. On whom are you putting pressure, the mothers and fathers who no doubt were too kind?

Funny thing, this country has reached an economic condition where only the disabled, sick and lazy do not work. This prosperity certainly was not brought on by the so-called teenagers.

As much as I disagree with the policies of the ARRL, I agree with its rule whereby a person must be of age to become a director. I have worked many teenagers on the bands and enjoyed their bright enthusiasm. They all seemed to show a certain amount of respect for an old timer. As a youngster, I had the highest regard for the fellows before me because they made it possible for me to enjoy a wonderful avocation. Then there are others like you who think with the possession of a little knowledge, you should be allowed to run everything. We seek your participation, suggestions and know-how but to become president of this grand country, I advise you to wait until you reach the constitutional age. Our founding fathers were not teenagers but I strongly suspect they knew what they were doing.

By the impatient trend shown by a very small minority of our youth, I have concluded that they think they will remain at age twenty or die at that ripe old age. What happens when they reach maturity? Do they fold up and say "let the kids do it"? I have an idea that when they get older they will get pushier.

So in a friendly manner I say to you, an older guy never has to get young but if you are lucky you will have to grow old. Think about it.

Until recently, the hams have been members of one big fat fraternity. Now added to the controversy created by incentive licensing, there are those, like you, who would pit young against old. OK, let the older ones take their assets out of circulation and let the kids start from scratch.

Come on, fellows, regardless of age or any other thing let's go back to having a little respect for each other, like.

Theodore DeCrescenzo W2DAD
244 Columbia Avenue
Jersey City NJ 07307

Gentlemen:

This morning I heard WA1KFJ come out with what must be the hardest-to-understand phonetic of the month, when he referred to K1MON as K1 Motion Ocean Notion. It doesn't take gnu, xylophone, and mnemonic to blow somebody's mind.

John A. Carroll K6HKB/1
34 Clark St. Apt. 13
Arlington MA 02174

Dear Wayne,

I am 18 years old and have been a ham for a little more than five years. So I guess I am relatively new in Amateur Radio compared with most hams and especially the Old Timers. I thought WA1GEK's article, 'Youth Forum," was simply an outlet for his frustration of maturing. Reading it objectively (which is hard for some of us teenagers sometimes) it sounds like he just wanted to use the article for an attack against the "establishment" which supposedly restricts so much freedom from teenagers.

Certainly I don't mean to say that I agree with everything the ARRL does, but I don't really see the urgent need for a teenage SCM. Why not try to influence the League's policies by writing to the SCM's, directors and other officers already in elected positions?Then there is also the question of whether or not a teenager has a sufficient amount of time for the job of that importance. We have our college or school commitments and some of us have time in the armed forces to do, and we like to run around a lot. I find it hard to believe that a responsible SCM consciously discriminates against teenagers who run for office if they have the ability for the job.

The article starts by briefly relating the youth protests against alleged evils of former generations. This discontent does little to improve the situation and many teenagers make it worse by dropping out and going hippy, yippy, or just plain left-wing reactionary.

Sure many adults are "dead from the neck up," but we should learn first how to become a more responsible, mature citizen before stepping in where perhaps wiser people fear to tread.

To affect productive changes in the existing order we must pursue a rational program with Old Timers helping younger beginners instead of repelling them from our great hobby-service by making distasteful remarks pointing up our inexperience and immaturity which we so desperately try to hide.

I think we accomplish more as hams helping other hams rather than as divided into "young generation hams" and "old generation (also called dead, apathetic, snobby, old fogie, etc.) hams."

Some minority groups in my generation question old standards and principles. We must realize that these ideas and institutions have the positive aspect of being time tested and have proved their soundness through more years than we have existed. Many can be improved; things must change with changing times in order to adapt to new situations and customs and to continue to be versatile. But things must change for the better. Indiscriminant experimentation can lead to confusion and regression rather than progress. It has been said that progress follows order. We shouldn't make hasty changes in basic institutions. Only until we believe it will be better after careful consideration can we modify existing ways.

I certainly hope ham radio will continue as one of the world's best hobbies. It can through mutual co-operation between the OT's and the beginner.

Sam Wells, Jr. WA5KTW
Box 7128
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Ruston LA 71271

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Robert G. Wheaton W5PKK
White Farm Dr., RR 2 Box 324D
San Antonio TX 78228

Dear Sir:

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Memphis TN 38117

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By the way–for the edification of George Taylor W4PZS, not only do my old friends still talk to me, but I have made many new ones as well. I recommend that he try it instead of knocking it.

R. E. Smith W5VFZ
Box 97
Organ NM 88052

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422 Macomber Street
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20,000 MFD- 15 VDC	2½" x4½"
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35,000 MFD- 12 VDC	2" x 6"
7,000 MFD- 13 VDC	1 3/8" x4½"
3,000 MFD- 25 VDC	1 3/8" x4½"
2,500 MFD- 45 VDC	1 3/8" x4½"
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chases used AM equipment and then finds he has practically no one to talk to except on 10 meters. I'm not knocking 10 meters however since as you see, I'm working this band myself and I have had a lot of fun doing so.

"73" should attempt to lead the way in this SSB changeover by featuring simple, low cost, low power transmitters and then perhaps we will find more of the AM fellows willing to make the changeover, and this would perhaps be of assistance to the novice who I believe has a problem.

In past years many good construction articles were used by the commercial builders to place on the market equipment amateurs found useful. If these builders found low cost, low power SSB equipment filled a need to certain members of our ranks, perhaps we would see some of it on the market.

I believe more of the old timers would make the changeover if it wasn't necessary to sell the XYL's mink coat and jewelry to do so.

In any event "73" is a great magazine, keep up the good work.

John A. Hunt W0POF
10626 St. Matthew
St. Ann MO 63074

Dear Wayne,

Thanks for the PC boards—it looks like an excellent job. The VFO seems to be working out well because I have had only one complaint from a guy who tried to use some HEP experimenter's transistor instead of the MPF-102. The MPF-102 usually must be obtained from a Motorola dealer or catalog rather than a general radio supply store. Another problem I found is that the output voltage is inadequate to drive some transmitters on all bands. This can be helped by adding a tuned circuit at the output of the amplifier with a few turn link coupling to the collector of the transistor. A toroid transformer would be more efficient and not have to be tuned, but I don't happen to have any toroid cores at the moment.

Cliff Klinert WB6BIH
520 Division St.
National City CA 92050

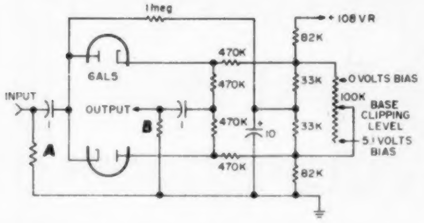
* * *

Errata & Addenda

Base Clipping—September

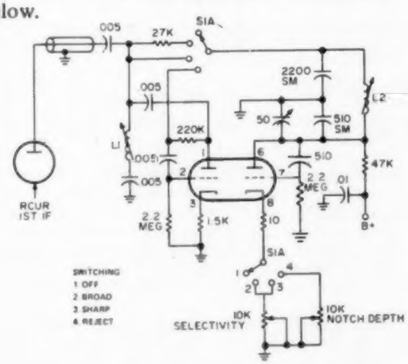
Figure 5 of the article "Improvement of Phone Intelligibility by Base Clipping" on page 69 of the September issue of 73 showed the input connected directly to the ground in the circuit. Quite a few readers caught this error and wrote to Ronald Ives, the author, about it. The corrected schematic is shown at the top of the next page.

A is the output load resistor of the leading circuit, whatever value it may be. B is the input resistor of the following circuit, whatever value that may be.


1meg
+108VR
82K
6AL5
470K
470K
33K
0 VOLTS BIAS
100K
BASE CLIPPING LEVEL
INPUT
OUTPUT
B
A
1
1
470K
10
33K
5 VOLTS BIAS
470K
82K

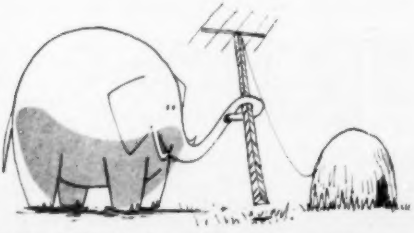
Q-Multiplier—October

Robert Grenell ex-W8RHR has let us know that the schematic for his Q-multiplier, illustrated in Figure 1, page 68, October 73, was missing some important bits of circuitry. The correct and complete schematic is given below.

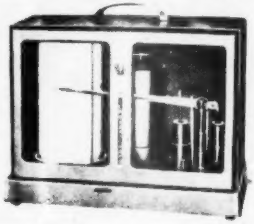

005
27K
S1A
2200 SM
005
L2
50
510 SM
220K
L1
.005
510
47K
005
2.2 MEG
.01
RCUR 1ST IF
2.2 MEG
1.5K
10
B+
S1A
SWITCHING
1 OFF
2 BROAD
3 SHARP
4 REJECT
10K SELECTIVITY
10K NOTCH DEPTH

The Ball of Wax, A Calibrator—November

The pc boards and a parts kit for the calibrator presented by Henry Olson W6GXN, in the November issue, are available from A.R.S. Enterprises, Box 555, Tempe, Arizona 85281. Due to an editorial oversight, this supplier's name was omitted from the article. Our apologies to A.R.S. Enterprises and to W6GXN.



"Lotta QRM all of a sudden, Jesse . . . hold on a moment and I'll go check the antenna connections."



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SG-13/ARN
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H.P.608D
H.P.612A
H.P.618A
H.P.620A
H.P.623C

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125MFD	450VDC	Elect.	.59	.10MFD	50V	Mylar	$ .07
1000MFD	10VDC	Elect.	.69	.047MFD	50V	Mylar	$ .05
500MFD	15VDC	Elect.	.49	.022MFD	50V	Mylar	$ .05
450MFD	20VDC	Elect.	.49	.0047MFD	50V	Mylar	$ .05
100MFD	50VDC	Elect.	.49	.0033MFD	50V	Mylar	$ .05
100MFD	15VDC	Elect.	.29	.68MFD	600V	Mylar	$ .59
100MFD	3VDC	Elect.	.19	.1MFD	600V	Mylar	$ .15
50MFD	50VDC	Elect.	.39	.25MFD	600V	Mylar	$ .19
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WANTED: TEST EQUIPMENT HP608 generator, RX meter, 704 Jerrold FSM, 601, 900 Jerrold Sweep Generator, HP130 oscilloscope or equivalent. VE3BVX, 11 Sussex North, Lindsay, Ontario Canada.

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SELL – SWAP: SB300 for SB110-A; HX-20, $95; power inverter 12 vdc–110 vac, 120 watt, $15; Gary Tater, 40 West St., Leominster MA.

600L CENTRAL ELECTRONICS linear amp—excellent condition. Price, $175.00.

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Dave Mann K2AGZ

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2. MARONIA _ _ _ _ _ _ _
3. RACACTINTA _ _ _ _ _ _ _ _ _ _
4. SANSAVA _ _ _ _ _ _ _
5. NIMSURA _ _ _ _ _ _ _
6. PLINPROCET _ _ _ _ _ _ _ _ _ _
7. CARUDEO _ _ _ _ _ _ _
8. RIALES _ _ _ _ _ _
9. CINCIVATATY _ _ _ _ _ _ _ _ _ _ _
10. SANDALEISTER _ _ _ _ _ _ _ _ _ _ _ _
11. GRUZORIDE _ _ _ _ _ _ _ _ _

(Solution on page 57)

PROPAGATION CHART

J. H. Nelson

December 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
	①	②	③	④	⑤	6
⑦	⑧	⑨	⑩	11	⑫	⑬
14	⑮	⑯	17	⑱	⑲	⑳
㉑	㉒	㉓	㉔	㉕	26	27
28 □	29 □	30	31			

Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	7	7	7	7	3A	7	14	21	21A	21
ARGENTINA	14	14	14	7A	7	7	14A	21A	21A	21A	21A	21
AUSTRALIA	21	14	7B	7B	7B	7B	7B	14B	21	21	21A	21A
CANAL ZONE	21	14	7A	7	7	7	14A	21A	21A	21A	21A	21
ENGLAND	7	7	7	3A	7	7B	14A	21A	21A	21	14	7
HAWAII	21	14	7A	7	7	7	7	7B	14A	21A	21A	21A
INDIA	7	7B	7B	7B	7B	7B	14	21	14	7B	7B	7B
JAPAN	14	14	7B	7B	7B	7	7	7B	7B	7B	7B	14A
MEXICO	21	14	7	7	7	7	7	14A	21A	21A	21A	21
PHILIPPINES	14	14	7B	7B	7B	7B	7B	14B	14	14	7B	14
PUERTO RICO	14	7	7	7	7	7	14	21	21A	21	21	21
SOUTH AFRICA	14	14	14	7A	7B	14	21A	21A	21A	21A	21	21
U. S. S. R.	7	7	7	7	7	7B	14A	21A	21	14	7B	7
WEST COAST	21	7A	7A	7	7	7	7	14A	21A	21A	21A	21

CENTRAL UNITED STATES TO:

ALASKA	21	14	7	7	7	7	3A	7	14	21	21A	21A
ARGENTINA	21	14	14	7	7	7	14	21A	21A	21A	21A	21
AUSTRALIA	21A	21	14	7B	7B	7B	7B	7B	14A	21	21A	21A
CANAL ZONE	21	14	14	7	7	7	14	21A	21A	21A	21A	21A
ENGLAND	7	7	7	3A	7	7	7B	14A	21A	21	14	7B
HAWAII	21A	21	14	7	7	7	7	7	14A	21A	21A	21A
INDIA	7B	14	7B	7B	7B	7B	7B	14	14	7B	7B	7B
JAPAN	21	14	7B	7B	7	7	7	7	7B	7B	7A	14A
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	7B	7B	7B	7B	7B	7B	14	14	7B	14A
PUERTO RICO	21	14	7	7	7	7	14	21A	21A	21A	21	21
SOUTH AFRICA	14	14	7A	7B	7B	7B	14	21A	21A	21A	21	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	14	7B	7B

WESTERN UNITED STATES TO:

ALASKA	21	21	7A	7	7	7	7	3	14	21	21A	21A
ARGENTINA	21	21	14	14	7A	7	7	14A	21A	21A	21A	21
AUSTRALIA	21A	21A	21	14	14	7B	7B	7B	14A	21	21A	21A
CANAL ZONE	21	14	14	7	7	7	7	14A	21A	21A	21A	21A
ENGLAND	7B	7	7	3A	7	7B	7B	7B	14A	21	14	7B
HAWAII	28	21A	21	14	7	7	7	7	14A	21A	28	28
INDIA	14	14	7B	7B	7B	7B	7B	7B	14	7B	7B	7B
JAPAN	21A	21	14	7B	7	7	7	7	7	7B	14	21A
MEXICO	21	14	7	7	7	7	7	14	21A	21A	21A	21
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7B	14	14	14B	21
PUERTO RICO	21	14	14	7	7	7	7	14A	21A	21A	21A	21
SOUTH AFRICA	14	14	7A	7B	7B	7B	7B	14	21A	21A	21	21
U. S. S. R.	7B	7B	7	7	7	7B	7B	7B	14	14	7B	7B
EAST COAST	21	14	7A	7	7	7	7	14A	21A	21A	21A	21

A = Next higher frequency may be useful also

B = Difficult circuit this period

Index To Articles
That Have Appeared in 73 Magazine in 1969

- Antennas - Feeders
  - See Beams
  - For Twoer—Jan 78
  - Slingshot—Feb 92
  - ½ Wave feed—Mar 58
  - Whip Repairs—Mar 58
  - VSWR Outmoded—Apr 55
  - Loading—Apr 58
  - Turnstile—May 8
  - Vacation Special—May 10
  - Short Vee—May 28
  - 40 M Dipole—May 30
  - Antenna scope—May 36
  - Two Band Vert.—May 40
  - Meas. Ant. Gain—May 42
  - T-R Switch—May 45
  - Novice Ant.—May 50
  - Long Wire Ants.—May 62
  - Basement Beams—May 66
  - 160 M Vertical—May 70
  - Gamma—May 73
  - 15 M Ant.—May 74
  - Kite Ant.—May 77
  - Better Angle—May 78
  - KW Dummy Ant.—May 92
  - Coax Switch—May 93
  - 150-30MHZ Curtn.—May 122
  - Vacation Ant.—May 130
  - Troubleshoot Indrs—Jul 44
  - CR Beam—Oct 73
  - SWR Mox Nix—Nov 28
  - RF Bridge—Nov 32
  - Umbrella Ant—Nov 46
  - Interaction—Nov 96
  - Hanging Ants—Nov 125
  - Coat Hngr Ant 2M—Jun 10
  - 2M Whip—Jun 58
  - 40-20-2 Ant—Jun 70
  - Coat Hangers, etc—Jun 80
  - Twist 2M—Jun 83
  - Mini-Vee—Jun 106
  - Passive Reflectors—Jul 91
  - Whip Add-on—Jul 104
  - 5/8 Wave vertical—Aug 14
  - 160M Ants—Aug 49
  - Skeleton Cone—Aug 133
  - 15M Curtain—Sep 4
  - Cable Pickup—Sep 36
  - 40M Super Ant—Oct 8
- ARRL
  - See QST
- Audio
  - Suppressor Comp—Jan 6
  - Selective Filter—Feb 12
  - Comp. Preamp—Mar 10
  - Zero Cycle Filter—Apr 60
  - Ancient Modulator—Jul 14
  - Notch Filter—Jul 72
  - Cable Pickup—Sep 36
  - Base Clipping—Sep 68
  - Taylor Mod.—Sep 84
  - Sine Generator—Sep 88
    (correction—Oct 131)
  - Mod Percentage—Sep 106
  - FET Compressor—Sep 138
  - Mike Mixer—Sep 140
- Beams
  - Tuning Beam—Jan 16
  - New Support—Mar 56
  - Tuning Quads—May 32
  - Matching Shortcut—May 38
  - Quad Feeding—May 52
  - Mini-Vee—Jun 106
  - Circular Quads—Aug 101
  - CR Beam—Oct 73
- Blind
  - Bridge—Jan 82
- Cabinets
  - Eq. Cabinets—Oct 64
- Careers
  - FAA—Feb 82
  - Broadcast Eng.—Aug 117
  - FAA—Oct 124
- CB
  - CB Sets on 6M—Oct 52
- Clock
  - Economy Clock—May 118
  - Kitchen Clock—Nov 121
- Clubs
  - Oper. Pub. Service—Jan 96
  - Ideas—Mar 79
  - Ham Jamboree—Oct 108
- Code
  - Learning Code—Apr 85
  - Code OSC—Oct 75
- Commercial Equipment
  - Drake R4A & T4X—Jan 76
  - Heath HW-18-3—Mar 50
  - Redline Minilab—Mar 82
  - Drake VHF Con.—Apr 56
  - Galaxy GT-550—May 48
  - James Monitor—May 68
  - James Key—May 68
  - Heath IT-28—Jun 64
  - Caringella ACP-1—Jun 71
  - M & M EK1 Keyer—Jul 126
  - Paxitronix IC-3—Aug 71
  - Knight V-107 VFO—Oct 123
  - Galaxy RV550—Dec 48
- Commercial Equip. Mod.
  - HW-12 on 160M—Jan 12
  - SB-610 Mon. Scope—Jan 26
  - Twoer—Jan 78
  - SB-610 Mods.—Apr 42
  - 2M Conv. for
    Swan 250—Apr 50
  - SB100 to 6M—Aug 74
  - NCX-3—Sep 6
  - NC-300—Sep 52
  - HX-10 Neutrlztn—Sep 80
  - SB-200 Mod—Sep 148
  - HW32A VFO—Nov 22
  - Swan TCU & 350—Nov 82
  - SB-33—Nov 90
  - SB-34—Nov 122
  - Swan 250 & TV2—Dec 26
- Compressor
  - Suppressor Comp—Jan 6
  - Comp. Preamp—Mar 10
  - SSB Escalator—May 127
- Console
  - Operating Console—Jan 52
  - Cabinets—Oct 64
- Conventions
  - See Hamfests
- Converters
  - See VHF
  - See Receivers
- Corrections & Mods.
  - Vackar Oct 68—Jan 102
  - Robbins Sep 68—Jan 102
  - 6M xcvr Sep 68—Jan 102
  - Micro Ult. Jun 66—Jan 102
  - 2M Rec. Oct 68—Apr 63
  - IC Counter Nov 68—Apr 63
  - Ham IC Dec 68—Apr 63
  - 2M xmtr Jan 69—Apr 63
  - 6 Net Jan 69—Apr 63
  - QRP Jan 69—Apr 63
  - SSB Clip. Dec 66—May 127
  - Tesla Feb 69—May 137
  - Antennascope May 69—Jul 87
  - Audio Gen Sep 69—Oct 131
- Covers
  - Dec-Feb Ampheham—Feb 76
  - Editorial—Jun 120
- Cross-Words
  - Oct 114
- CW
  - See Keying, Filters
  - CW Here OM—Feb 90
  - CW for VHF xmtrs—Jun 12
  - CW VOX—Aug 45
  - Magikey—Aug 68
  - CW VOX—Sep 125
  - Q-mult.—Oct 68
  - Unikey—Nov 66
- DX & Contests
  - Yasme DXpedtns.—Jan 32
  - Around the World—Jan 71
  - European VHF—Jan 100
  - Cold Down There—Feb 74
  - No Borders—Mar 32
  - W1FZJ/W1HOY/KP4—May 90
  - KV4AA—May 91
  - Without 6 elements—May 26
  - Super SS—May 51
  - DX from DL—May 96
  - Phonetics—May 98
  - DX Desk—Jun 54
  - Rio de Oro—Jul 38
  - Greatest of All—Jul 80
  - Navassa Open—Aug 111
  - Iran Amateurs—Aug 138
  - JA Prefixes—Sep 150
  - DX Corner—Oct 12
  - VP2KC—Oct 70
- Extra Class License
  - See License Study
- FAX - Facsimile
  - See SSTV
  - Facsimile—Jun 84
  - Converter—Jun 130
- FCC
  - Number of Licenses—Feb 4
  - New Amateurs—Mar 4
  - RM-1311—Jul 99
  - RM-1429—Jul 138
  - RM-886-950-981—Sep 153
  - RM-1455-1456—Oct 127
- Fiction
  - Charlie's
    Broken Dream—Mar 66
- Field Day
  - See Operating
- Filters
  - Selective Aud.Filt.—Feb 12
  - Zero Cycle Filter—Apr 60
  - Notch Filter—Jul 72
  - Xtal Phasing—Oct 58
  - TVI Filter Test—Nov 65
  - Tuned Filt. Chokes—Dec 18
  - Easy Selectivity—Dec 28
- FM
  - AN/VRC-19—Jul 76
  - Listen to Repeater—Aug 4
  - Multi-Channel—Aug 12
  - Basics—Aug 72
  - Deviation Meter—Aug 96
  - Rec. Noise Fig—Aug 112
  - What About FM?—Sep 96
  - AM Xmtrs on FM—Oct 50
  - FM Practices—Oct 66
  - Repeater Freqs.—Oct 139
  - Mobile Inst.—Nov 80
  - Rec. Align—Nov 80
- Frequency Marker
  - See Test
- Hamfests
  - Editorial—Feb 78
- History
  - Tesla—Feb 38
  - Lamb Dyer—Mar 64
  - Ecstacy—Apr 14
  - Who's Who—May 4
  - First QSL—May 87
  - Facts & Fads—Jul 68
  - Genesis of Recep.—Aug 22
  - WWV—Sep 39
  - Tesla—May 137
  - Electrostatics—Nov 56
  - Apollo TV & Radio—Nov 58
  - Morse—Dec 10
- Hoisington
  - 432'er Solid State—Jun 24
  - Light Runs Down—Sep 24
  - 432 Xmtr—Nov 50
  - 1-10 GC Freq. Mtr.—Dec 72

- Humor
  - Zero Cycle Filter—Apr 60
  - In the Beginning—May 20
  - Mondo Hamme—Jun 14
  - Field Day Fever—Jun 40
  - Appliance Op—Jul 2
  - CW Can Get Your Goat—Jul 36
  - Uncle Will—Sep 19
  - Vidiots I Have Known—Oct 34
  - Cat's Paw—Oct 116
  - Call Letters—Nov 94
- I. F.
  - Alignment—Jan 61
  - Alignment—Mar 65
- Incentive Licensing
  - See License Study Course
  - Number of Licenses—Feb 4
  - New Amateurs—Mar 4
- Integrated Circuits
  - Introduction—Aug 26
- Keying
  - Sequential—Jan 74
  - Charmin Keyer—Mar 22
  - James Monitor—May 68
  - James Key—May 68
  - CW VOX—Aug 45
  - Magikey—Aug 68
  - Unikey—Nov 66
- Leaky Lines
  - Jun 68
  - Aug 66
  - Sep 144
  - Oct 28
  - Nov 4
- Legal
  - TVI Suit—Feb 36
  - More TVI Suit—Apr 4
  - Suit Report—May 138
- Linears
  - Linear Improve.—Jan 22
  - Tri-band—Feb 10
  - Mini-Bomb—May 94
  - 6M Linear—Jul 20
  - 3-400Z—Sep 124
- Math
  - Easier Calculations—Dec 50
- Mobile
  - See FM
  - Go Mobile—Feb 58
  - Generator—May 24
  - Theft Protector—Jul 12
  - Clothes Line Ant—Jul 25
  - Heater Switching—Oct 39
  - Power Supplies—Dec 70
- Modulation
  - See Transmitting
- Modules
  - Pill Box Module—Jan 51
- Monitoring
  - Heath SB610 Scope—Jan 26
  - Panadapter—Jan 44
- Morse Code
  - See Code
- Nets
  - Interest Nets—Jan 104
- Networks
  - LC Power Reducer—Jan 38
  - Attenuatot Network—Dec 14
- Noise Limiting
  - Series Gate—Sep 50
- Operating
  - Operating Console—Jan 52
  - Phonetics—May 98
  - Field Day Fever—Jun 40
  - Memorable Field Day—Jun 44
  - Ad Libbing—Jun 133
- Oscillators
  - Freq shift calc.—Jan 58
  - Xstr osc.—Mar 44
- Panadapter
  - See Monitoring
- Patching
  - To or Not To—May 56
  - Phone Beeper—May 88
  - Telephone—Oct 24
- Phone-Patch
  - See Patching
- Poetry
  - Rhyme with Reason—Jul 78
- Power Supply
  - HV Supply Impr.—Jan 22
  - Voltage Control—Jan 24
  - Adjustable Supply—Mar 40
  - Transformer Rpr.—Mar 42
  - Var. D.C. Load—Apr 18
  - OA2 Problem—Apr 26
  - Triac—Aug 59
  - Tubes to Diodes—Aug 111
  - Diode Stacks—Sep 74
  - Capacitor Covers—Sep 83
  - Protector—Oct 40
  - P.S. for Xcvrs.—Oct 83
  - Sextupler Supply—Nov 62
  - For Transistors—Nov 72
  - Elect. Variac—Nov 88
  - More VR Current—Nov 125
  - Tuned Filt. Chokes—Dec18
  - Current Limiter—Dec 31
  - Mobile P.S.—Dec 70
- Preamplifier
  - See Audio
- Propagation
  - Better Angle—May 78
  - 6M DXing—Jun 48
  - Forecasting—Jul 62
  - Solar Flares—Jul 80
  - Primer—Sep 98
- Public Relations
  - Classroom—Dec 40
- Public Service
  - Operation Pub Ser—Jan 96
  - No Borders—Mar 32
  - Amateur & C.G.—Aug 122
  - Our Purposes—Aug 134
- Pulsars
  - What's Out There—Feb 24
- QRP
  - 40M 1 tube—Jan 62
  - Quick & Easy—Jan 72 (also see Apr 63)
  - 6M Rig—Apr 48
  - New World—May 46
  - 6M Rig—Sep 12
  - Xstr Rigs—Sep 64
  - 2½w Xmtr—Sep 78
- QSL
  - New Way to QSL—Jul 24
  - Outgoing Bureau—Aug 109
- QSO's
  - Interest Nets—Jan 104
  - Avoid Routine—Apr 28
  - Religion & Sex—Nov 40
- QST
  - Letter W7ZC—Mar 71
  - Suggestions—Mar 77
  - W7ZC Letter—May 132
  - W2AFJ Letter—May 133
  - W4PZS Letter—May 134
  - Board Meeting—Aug 2
  - Pro ARRL—Aug 107
  - Replace ARRL?—Aug 140
  - Elections—Sep 136
  - QST Board—Oct 76
- Radio Control
  - R C Revisited—Jul 49
- Receivers
  - 6M Net—Jan 48 (correction Apr 63)
  - Weather—Mar 18
  - Simple Preamp—Apr 10
  - 2M Converter—Apr 52
  - 6M FET Convr—Jun 34
  - Compleat AVC—Jun 36
  - Police Converter—Jun 104
  - Tubes to FET—Jun 114
  - S-Mtr. de Pegging—Jul 43
  - Simple BFO—Jul 71
  - Solar Flare Rec.—Jul 80
  - 2M Converter—Aug 4
  - FET Regen—Aug 6
  - FM Noise Fig—Aug 112
  - 6M Converter—Sep 13
  - Series Gate Lim—Sep 50
  - Autobandwidth—Oct 31
  - Slower Tuning—Oct 42
  - Calibrator Harm.—Oct 46
  - Xtal Filt. Phasing—Oct 58
  - Q-Multiplier—Oct 68
  - IF Notch Filter—Nov 14
  - Calibrate Dial—Nov 18
  - 6M Converter—Nov 25
  - Rec as Test Eq.—Nov 60
  - Rec Tweeker—Nov 80
  - Calibrator—Nov 84
- RTTY
  - Why Ham RTTY—Jan 42
  - Autostart—Jan 56
  - FSK Exciter—May 84
  - Scope—Jun 78
  - T. V.—Jul 65
  - Tone Generator—Aug 32
  - AFSK Gen.—Sep 53
- Scanning the Flyers
  - Radio Shack—Aug 137
  - Six Flyers—Oct 129
- Slow Scan TV
  - See TV
  - Converter—Jun 130
  - VS Facsimile—Sep 150
  - Color—Nov 20
  - SSTV—Dec 34
- Soldering
  - Tip Tip—Mar 73
  - Tip Last Longer—Jul 127
  - Soldering Outfit—Sep 20
  - De-Solder—Sep 79
  - P.C. Soldering Aid—Oct 11
- Spectrum Analyzing
  - See Monitoring
- Speech
  - Suppressor Comp.—Jan 6
- Surplus
  - TCS Mods.—Mar 6
  - Kluge Tube—Mar 68
  - Catalog—Mar 97
  - Conversion List—Mar 96
  - Band Scanner—Jun 127
  - AN/VRC-19—Jul 76
  - Ft Surp. Xtals—Aug 76
  - Freq. Surp. Xtals—Aug 76
- SWR
  - SWR Bridge—Apr 22
  - VSWR Outmoded—Apr 55
  - Indicator—May 60
  - Connectors—May 66
  - VSWR Letter—Jul 133
  - SWR Mox-Nix—Nov 28
- Technical Aid Group
  - Jan 80
  - Mar 94
  - Jun 110
- Telephone
  - Inside Bell—Oct 24
- Test
  - Rack Test Leads—Jan 54
  - IF Alignment—Jan 61
  - Sightless Ops Brdg—Jan 82
  - Mini-Lab—Mar 82
  - Scope Preamp—Apr 6
  - Var. DC Load—Apr 18
  - SWR Bridge—Apr 22
  - 100 khz gen.—Apr 24
  - SB610 Mods—Apr 42
  - Burst Gen.—Apr 50
  - S-unit Atten.—May 14
  - Antennascope—May 36 (correction Jul 87)
  - SWR Indicator—May 60
  - IC Count. Readout—May 66
  - Tube Substitution—Jul 88
  - Transistor Checker—Aug 41
  - Ft Surp Xstrs—Aug 46
  - 430-470 Sweep—Aug 62
  - Xstr Parameters—Aug 128
  - Meter Resistance—Sep 72
  - Audio Generator—Sep 88
  - Xstr Testers—Sep 133
  - Incr. Dipper Rnge—Sep 158
  - FET Chirper—Oct 20
  - Scope Calibrator—Oct 32
  - Calibrator Harm.—Oct 46
  - RF Bridge—Nov 32
  - Rec as Test Eq.—Nov 60
  - Calibrator—Nov 84
  - Diode Checker—Dec 6
  - Xtal Calib—Dec 58
  - Freq. Meter—Dec 72
- Theory
  - See License Study
  - See Transistors
  - Reactance—Mar 14
  - VSWR Outmoded—Apr 55
  - Loading—Apr 58
  - Tuning a Circuit—May 124
  - Intro. to I.C.—Aug 26
  - Triac—Aug 59
  - Tunnel Diodes—Sep 8
  - Light Runs Down—Sep 24
  - Transistors—Sep 42
  - Capacitor Usage—Sep 90
  - Propagation Primer—Sep 98
  - Class A-B-C Design—Dec 64
- Towers
  - New Support—Mar 56
- Transceiver
  - Heath 160M HW18—Mar 50

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Cool It—Mar 54
Transistors
Unijunction—Feb 14
Oscillators—Mar 44
RF Pre Amp—Apr 10
Silicon Survey—Apr 30
Class A Design—May 72
Microwave Power—Jun 4
Checker—Aug 41
Ft. Meas.—Aug 46
Triac—Aug 59
2 Xstr Xmtr—Aug 98
Parameter Tracer—Aug 128
Magic T—Sep 14
Theory—Sep 42
Blowing Transis.—Sep 64
Testing Technqs.—Sep 76
2½w Xmtr.—Sep 78
Testers—Sep 133
Bias Design—Nov 74
Transmitting
2M Xstr+1—Jan 28
(correction Apr 63)
Power Reducer—Jan 38
40M 1 tube—Jan 62
Quick QRP—Jan 72
Sequential Keying—Jan 74
Tri-band Linear—Feb 10
VFO Hum—Feb 91
TCS Mods—Mar 6
Balanced Mod.—Mar 36
Cool It—Mar 54
6M QRP—Apr 48
4 x 150 Sockets—May 120
6M SSB Exciter—Jun 18
6 + 2 VFO—Jun 124
Ancient Mod.—Jul 14
160M VFO—Jul 100
2M Exciter—Jul 128
3.5-30 mhz VFO—Jul 128
2M Xmtr—Aug 98
Magic T—Sep 14
2½ w Xmtr—Sep 78
Taylor Mod—Sep 84
Mod. Percentage—Sep 106
3-400Z Linear—Sep 124
Plate Choke—Sep 147
AM Xmtrs. on FM—Oct 50
Spotting Switch—Nov 145
Crystal Oven—Oct 54
G.G. Fil. Chokes—Oct 62
Attenuator—Dec 14
SSB Carrier—Dec 22
Incremental Tun.—Dec 62
Tubes
Tube Substitution—Jul 88
Tubes to Diodes—Aug 111
Cooling—Sep 87
TV
See Slow-Scan TV
Vidicon SSTV—Feb 6
Video Modulator—Jun 74
SSTV Sig Gen—Jul 16
Vidicon Camera—Sep 129
TVI
Suit Filed—Feb 36
Ban The Ham—Apr 4
RF Tape—May 121
Report on Suit—May 138
UFO
Sudden Interest—Jan 70
What's Out There—Feb 24
Letter—Mar 70
Velcro
New Material—Feb 32
VHF and UHF
See 2 meters & 6 meters
European VHF—Jan 100
Twoer PTT—Apr 16
Burst Gen—Apr 50
Drake Converters—Apr 56
Vacation Ant.—May 10
Microwave Power—Jun 4
CW for Xmtrs—Jun 12
432'er-Solid State—Jun 24
Designing Tuners—Jun 60
6M Converter—Jun 66
Promoting VHF—Jun 73
FET Pre Amps—Jun 76
Cavitiest Lines—Jun 102
Band Scanner—Jun 127
6M Linear—Jul 20
432 Amp—Jul 27
432'er—Jul 32
6M IC Converter—Jul 46
Passive Reflectors—Jul 91
2M Exciter—Jul 108
2M Converter—Aug 4
2M Xmtr-2E26—Aug 42
SB100-6M—Aug 74
Circular Quads—Aug 101
FET Chirper—Oct 20
CB Sets on 6M—Oct 52
CR Beam—Oct 73
6M SSB—Nov 6
432 Xmtr—Nov 50
Weather
Weather receiver—Mar 18
Workshop
Rack Test Leads—Jan 54
Soldering Tip—Mar 73
Wrinkle Finish—May 142
PC Board Imp.—Jul 75
Solder Gun Tip—Jul 127
Soldering Outfit—Sep 20
WTW
Report—Mar 74
—Jun 54
—Oct 12
WWV
Description—Sep 39
432'er Solid State—Jun 24
FET Pre Amp—Jun 76
Coat Hangers—Jun 80
KW Amp—Jul 27
432'er—Jul 32
Xmtr—Nov 50
Freq. Meter—Dec 72
2 Meters
Xstr Xmtr + 1—Jan 28
(correction Apr 63)
Twoer—Jan 78
Twoer-PTT—Apr 16
Converter—Apr 52
Turnstile Ant.—May 8
Vacation Ant.—May 10
Coat Hanger Ant.—Jun 10
Whip Ant.—Jun 58
Monitor—Jun 68
Pre Amp FET—Jun 76
Twist—Jun 83
AN-VRC-192M-FM—Jul 76
Xstr Exciter—Jul 108
Converter—Aug 4
2E26 Xmtr.—Aug 42
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6M
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SSB Exciter—Jun 18
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DXing—Jun 48
6M Converter—Jun 66
KW Linear—Jul 20
IC Converter—Jul 46
SB100-to 6M—Aug 74
Solar Powered Rig—Sep 12
Converter—Sep 13
2½ w Xmtr—Sep 78
CB Sets on 6M—Oct 52
SSB with NCX3—Nov 6
3 Xstr PC Conv.—Nov 25
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INDEX TO ADVERTISERS

Adirondack 95
Alden 99
Amateur Whisle Elec. 35
Ameco 29
American Crystal 133
Amidon 29
Antennas Inc. 69
Antenna Mart 87
Arcturus 143
Arnolds 97
ATV 99

B & F 129
Bigelow 142
Brigar 134
Burghardt 93

Callbook 4, 63, 91
Caringella 81
CB Radio 99
Columbia 125
Cushcraft 81

Dahl 125
Delta 13
Denson 142
Denver Crystal 137
DGP 65
Dow-Key 21
Dow Trading 131
Drake 5

Epsilon 134
Estes 93

Fair Radio 97
Freck 61

Galaxy II
Gateway 91
GBC America 131
G & G 127
Global Import 97
Goodheart 133

Hafstrom 85
HAL Devices 87
Hatry 89
HJC 97
Heath 11
Heights 25
Henry 19
Hirsch 95
H & L 99

International Crystal 3

James Research 104, 105
Jan Crystal 109
Jeff-Tronics 138

Lewispaul 139
Liberty 144

Linear Systems 23

Megart 87
Meshna 135
Microflect 109
Micro Z 71
Mosley IV
Murch 85

National Radio III
Newport Marine 136

Omega-T 63

Pantronics 125
Park 111
Pickering 123
Poly Paks 143

Quement 33

Radiation Products 137
R & R 138
Redline
Rohn 15

Salch 45
Signal One 47
Skylane 139

Slep 136
Stardust 61
Stellar 55
Swan Antenne 31
Swan 38, 39

Telrex 44
Tower 31

UFO Net 142
Unadilla 49
United 137

Vanguard 4, 57
Varitronics 43
VHF 89
Vibroplex 125

Western 133
WRL 46
World QSL 131

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Binders 143
Books 100, 101
Club Finagle
Gunsmoke
Radio Today 41
Subscriptions 107

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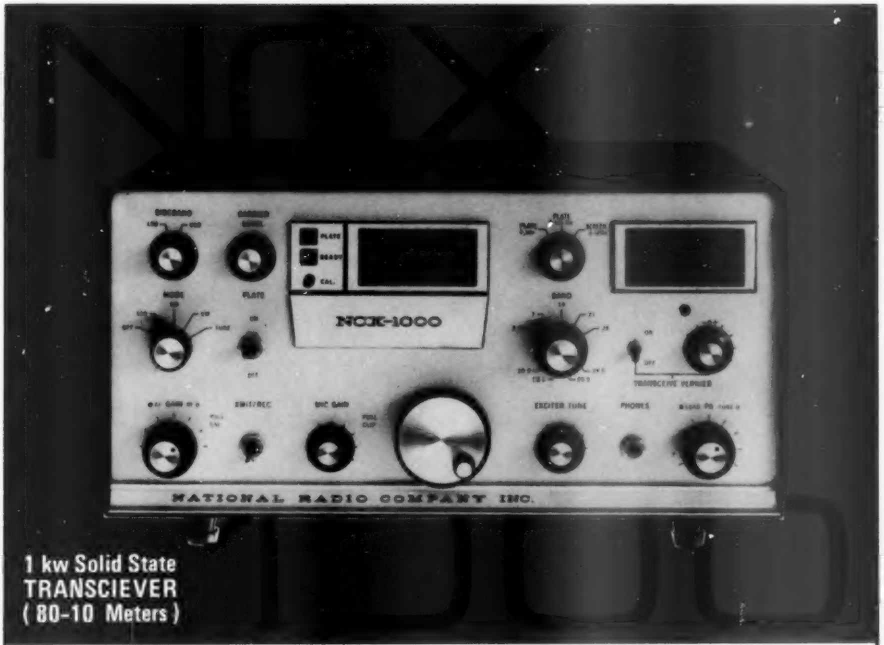

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